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ELECTRICITY
AS RELATED TO
MEDICINE AND SURGERY

ROCKWELL.

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LECTURES

ON

ELECTRICITY

IN ITS

RELATIONS TO MEDICINE AND SURGERY.

BY

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PREFACE.

The instruction that I have from time to time given to practitioners of medicine, on the theory and practice of Electro-Therapeutics, is here very incompletely embodied. The lectures were published in consecutive numbers of the *Virginia Medical Monthly* at the request of its Editor, and although necessarily much restricted in scope and practical detail, will, I trust, open to the reader a fair view of the field of Electro-Medicine and Surgery, as seen from the standpoint of the writer. It may be suggested, that in consideration of the more exhaustive work that has been for some years before the profession, this brochure was uncalled for. If any apology is due, it is offered in consideration of the fact, that in addition to its general survey of Electro-Therapeutics it gives some points that are not discussed in the present edition of our larger work; and again that while a number ot books on this subject, equally concise, have been issued, in none of them are our methods of general faradization and central galvanization given any adequate consideration, and by some are not even mentioned. These methods, although sufficiently familiar by name to the profession, are yet but illy understood and appreciated, and until there prevails a wider experience in their *modus operandi*, and a better knowledge of their rationale and effects, it will be impossible to completely discard the error that electrization is merely an irritant and stimulant, and rise to a full conception of its tonic and soothing powers.

A. D. Rockwell.

46 *East* 31*st Street, New York.*

LECTURES ON ELECTRICITY

AS RELATED TO

MEDICINE AND SURGERY

LECTURE I.

ELECTRO PHYSICS.

The subject of electricity in its relation to disease, upon which I am to speak to you, is sufficiently extensive to occupy far more time than is allowed us. I shall therefore content myself with dealing briefly with those points that are more especially practical, hoping that what I shall say and demonstrate may awaken an interest in an important, though neglected, field.

In one sense, there is no department of medicine in which there is greater activity than in electro-therapy. If we may believe the aphorism, however, of one of the truest philosophers of the century, "there is nothing more terrible than activity without insight;" and it is this very activity that prevails, guided by no intelligent insight into the laws which govern and the principles which underlie electro-therapeutics, that has been its rock of offence and stone of stumbling.

Electricity, although the legitimate property of the educated physician alone, draws to it, more than any other therapeutic means, the folly, ignorance and cupidity of the land; and in every effort to wrest it from the hands of the charlatan, we are simply repeating the history of almost every special department of medicine. Much has indeed already been accomplished, and in all probability its future status is secured; for it rests on foundations too broad to be easily overthrown.

But it has grown and is still growing in spite of the opposition of many, who would relegate its use to ignorant attendants, or to the patients themselves, or who, with limited knowledge of the subject, and less experience in its use, assert that their efforts and results compass all that there is to electro-therapeutics.

The three main divisions of the subject are—1st, Electro-physics; 2d, Electro-physiology; and 3d, Electro-therapeutics—the latter being the science that treats of the study of electricity in its relations to disease. Electro-therapeutics, therefore, includes both electro-medicine and electro-surgery.

Before proceeding to consider the subject of electro-physics, in so far as it is necessary to a clear understanding of electro-therapeutics, it may, perhaps, be not amiss to glance briefly at the history of electro-therapeutics. Like so many other departments of medicine, its beginnings are shrouded in obscurity. Its real history, however, may be divided into three eras: Era of Franklinic Electricity; era of Galvanization; and era of Faradization.

In the *Franklinic era*, only franklinic electricity was used—galvanic and faradic electricity not yet having been discovered. The methods employed were by the electric bath, and electrization by sparks and shocks from the Leyden jar. There were many reports of cures by eminent members of the profession; but in a memoir presented by Maduyt in 1773, we find a most concise summing up of what experience has since taught us to be a most accurate estimate of the therapeutic action of electricity. He reports it to be a "remedy of vast and varied powers—possessing a most powerful influence over nutrition, equalizing the circulation, materially affecting the pulse, the perspiration and the secretions, and surprisingly efficacious in the treatment, not only of paralysis, but also of many other conditions, such as constipation and œdema."

The *era of Galvanization* begins with the discovery of animal electricity by Galvani in 1786; but it was not until Volta invented the voltaic pile in 1800 that the medical use of the galvanic current was attended with any degree of satisfaction. Imperfect as it was, it was vastly superior to the metallic plates which had been employed since Galvani's discovery.

The discovery of *Inductive Electricity*, however, by Faraday, in 1831, changed the whole course of electro-therapeutics, since the electric machines, immediately constructed, were more convenient and reliable than the old voltaic piles.

From this time electricity began to be more extensively used—I should, perhaps, say abused—and by the laity more than by the profession. It is only within the last ten or twelve years (if we except the efforts of Remak and Duchenne) that any approach to systematic investigation has been attempted, and an agent powerful for good, but capable of vast injury, given a place in the armamentarium of the profession. Up to the time when inductive electricity was discovered, and for some time thereafter, it was used without any recognized method, and, as a rule, without any very clear ideas of the indications for its use. Gradually, however, as experiences began to be systematized and compared, distinct methods of electrization were introduced, embracing all applications of both faradic and galvanic electricity.

These methods are: Localized faradization, localized galvanization, general faradization and central galvanization—all of which I propose to speak of more in detail further on.

It is hardly necessary for me to assert that no one can be proficient in any department of science, without at the same time having a fair understanding of its foundation principles. Now, in this presentation of the subject, it will be impossible for me to explain all even of the leading principles of electro-physics, much less to refer to all their practical bearings on electro-physiology and electro-therapeutics. These can, in detail, be gleaned from various treatises upon the subject, and at your leisure. I shall attempt simply to present certain of the most prominent and important features of the subject, sufficient for a ready understanding of what is to follow; and although some of you may be more or less proficient in this part of our topic, you will bear with me if I, for the time, regard my hearers as tyros and speak accordingly.

Electricity is a generic term, under which is included three general forms—viz., magnetism; statical or frictional, or franklinic electricity; and current or voltaic, or dynamical electricity. With magnetism, we have very little concern. Artificial and natural magnets were at one time supposed to exert curative influences in the relief of pain, &c., and there have been various reports in its favor; but it is quite evident that whatever benefit followed its use, was due quite as much to the influences of the imagination as to anything else. Statical or frictional electricity, as generated by the old-fashioned cylinder machine, you are all probably familiar with. It has been more used in hospitals than in private practice; and although it is of unquestioned utility, yet it is generally admitted, that whatever can be done with it, can be accomplished by dynamic electricity, while the latter has, also, a far wider range of usefulness. Static electricity, therefore, we shall not consider further.

The third form of electricity, viz., current or dynamic electricity, will mainly engage our attention, since it occupies the chief place in electro-medicine and surgery. Under this head we have—1st. That form called galvanism or voltaic electricity—the result of chemical action; and 2d. Induced electricity, electro-magnetism or magneto-electricity—the result of current or magnetic induction. You are to understand that these varieties, just indicated, are called dynamical or current electricity—signifying electricity in motion, to distinguish it from static electricity—signifying the electrical condition of bodies, in which electricity remains insulated or stationary. And yet, under certain circumstances, dynamic electricity becomes, as it were, statical; for if the poles of a series of galvanic batteries are insulated, they manifest, before the current begins, the electric tension of a frictional machine.

Much confusion has arisen, and still exists, in regard to the different manifestations of current, because of the loose nomenclature that prevails. There is an indiscriminate use of the terms induced, constant, galvanic, direct, secondary, etc., serving only to mystify and mislead. The subject becomes very much simplified if we bear in mind that the third or dynamical kind of electricity, with which we have principally to deal, manifests itself, as I have before stated, in two forms of currents—viz., the galvanic, so-called after Galvani, the discoverer of chemical action; and, second, the faradic, after Faraday, the discoverer of the principle of induction. Recollect, also, that the synonyms of the term galvanic are as follows—viz., constant, primary, voltaic and direct; the synonyms of the faradic being the induced, secondary, interrupted, electro-magnetic and magneto-electric—the latter synonym being used when the current is induced through a permanent magnet, instead of through chemical action. It is, I suppose, vain to hope that the two simple terms galvanic and faradic will be adopted in all references to the subject, and if, therefore, the synonyms above enumerated are remembered, much annoyance will be obviated.

I have emphasized this subject of nomenclature, but I think not unnecessarily; for I constantly find the greatest amount of misconception existing among those who have batteries, and who are supposed even to be somewhat informed.

The history and nomenclature having been thus briefly disposed of, it remains for me to make as clear as possible the chemical action of the simple galvanic cell, in which is generated the galvanic current, and then to explain to you the principle of induction, through which we have the faradic current.

As you are well aware, in the formation of a single galvanic circle there are usually two metals and a liquid. The strength of the current generated depends mainly upon the strength of the solution, and the combination of elements immersed in it. It is well, therefore, that you should understand that the various elements that are used in batteries, have a natural electro-chemical arrangement—as, for example, zinc, copper, silver, platinum, gold, carbon. Each substance in this abbreviated series is positive to any substance below it, and negative to any one above it. Thus, copper, when associated in a galvanic pair in the proper fluid, with any one of the elements that follow it, generates positive electricity; but when associated with the element preceding it, generates negative electricity.

The more electro-negative any one of the elements in this series is to a given element, the more intense will be the current generated, when they are united in a galvanic pair. In other words, the further removed any two elements are from each other in this series, the greater is the tension of current when they are combined in a single cell. I have before you one of the simplest, but at the same time one of the most efficient, cells for practical purposes. It is called Smee's cell, and is composed of two plates of zinc and one of corrugated platinum. When immersed in a solution of sulphuric acid, what takes place? In common language, simply this—an electrical disturbance is observed over all the surface of the zinc covered by the fluid. Positive electricity is generated at the zinc element and flows through the liquid to the platinum.*

The electricity is generated wholly by the chemical action of the acid upon the zinc, and other things being equal, the quantity of electricity set in motion will be proportional to the extent of zinc surface exposed to the acid.

Right here, there is one important practical point which I will mention, for a knowledge of it will enable you to tell in any galvanic battery which is the positive and which the negative pole. The zinc is said to generate positive electricity; and yet it is always the negative pole, from the fact that, in the liquid, the positive electricity of the zinc flows towards the platinum, and the negative electricity of the platinum towards the zinc, and thence through the circuit outside the cells. Because for the sake of convenience, we speak of electricity as a current flowing in certain directions, it is not to be supposed that it is a real fluid.

This old Franklinic hypothesis has long since been abandoned. We may suppose that as light consists of undulations of ether, so we may believe that electricity consists of movements of a different kind—is, in short, simply a mode of motion.

At this point, there are two terms—*quantity* and *tension*—that should be explained. I shall refer to them in the simplest language, for a thorough scientific explanation would necessitate a consideration of Ohm's law, which, although of great importance, cannot be elucidated here. *Tension*—a *result* of electro-motive force—is that quality of electricity by which it overcomes resistance. The tension of a battery depends upon the number of its cells; while *quantity*,† signifying that amount of electricity which passes through a circuit in a given time, depends upon the size of the elements in the cells. The action of the liquid upon the surfaces of the zincs, causes the same electrical disturbances in each cell. The liquid becomes positive, while the zinc above the liquid becomes negative. The positive electricity of the liquid is conducted through the platinum plate (Smee's cell) to the negative zinc of the next cup, where it becomes exactly neutralized. We obtain, therefore, no more quantity from 100 cells than from a single cell, but a greatly increased tension. The relative meaning of these terms quantity and tension may be best understood by an illustration. A gallon of water heated to 100° has a much greater quantity of heat than a pint heated to 200°; but the heat of the latter is much more intense.

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*The chemical changes that take place in the battery will be considered when we come to speak of that part of electro-surgery termed electrolysis.

†The term quantity is retained for convenience. By it more than by the term tension is understood the *strength* or working power of the current.

Faradic electricity, the second division of current electricity, is the current of induction.

The current from a simple galvanic circle, passing through a coil of wire, induces, simply by proximity, a secondary current in a second coil of wire—differing altogether in its physiological effects from the galvanic current.

These induced or secondary currents, again, have the power to induce currents in other coils of wire called tertiary currents, and so on for a long series. The strength of the current decreases, however, the higher they ascend; hence, batteries constructed for therapeutical purposes have no more than the two coils. By putting a bar of soft iron, or a bundle of iron wires, within the primary coil, the current becomes very much strengthened, and in this way, the momentary action of the current, as it is closed, causes the iron bar or wires to become magnetic. As the current opens, this magnetism disappears—its disappearance inducing a current in the same direction as the disappearing primary current. For the uses of therapeutics, therefore, this iron core is a very convenient means for modifying the current. Instead of an iron core, however, the machines that are now constructed have their entire coil covered by a cylinder of tin. When this tube covers the helix, an indefinite number of branch currents are induced in it, that interfere with the main current, and weaken it. In proportion as this is withdrawn, the induction of branch currents, and the consequent interference with the main current, grow less.

The wire of a primary coil is made quite large, because it is a law of electro-physics, that the thicker the wire the better is electricity conducted, and the more readily is magnetism excited in the iron core. The secondary coil is, however, made of very thin wire and of great length, so that as many turns as possible may be brought within the influence of the core and of the primary coil, and thus produce a secondary current. As with the galvanic or inducing current, the electro-motive force of the battery is proportionate to the number of cells, so with the induced or secondary current, the electro-motive force of the coil is proportionate to the number of turns or coils in it.

There are two forms of faradic batteries, varying materially in construction and in physiological action. These are termed, respectively, the single or continuous, and the double or separate coil machines. In the first named, there is a continuous wire, varying, however, in thickness in different parts of its course. This wire is tapped at different points, and the quality of the current generated, depends upon the length and thickness of the coils included in the circuit. In the separate coil machine, the helix is composed of two entirely separate and distinct wires, the inner or inducing coil of wire being thicker than the outer coil. Now, it is not a matter of indifference in what way a helix is constructed. Every modification of a conductor in length, thickness or constitution, more or less modifies the quality as well as strength of the current; and, therefore, the current proceeding from these different forms of helices, as well as from the different portions of the continuous coil helix, vary considerably in their action.

It is difficult, and perhaps impossible, to arrive at any satisfactory conclusion in regard to the relative therapeutic effects of the continuous and separate coil machines through physiological or theoretical considerations alone. Clinical experience serves us best here; and guided by it, I have found that the current proceeding from the single or continuous coil is to be preferred in the treatment of nervous and hysterical patients, and for the production of those tonic effects that are aimed at in the administration of general fara dization. On the other hand, in many cases of anæsthesia and loss of electro-muscular contractility and impaired virility, the current from the separate coil answers a better purpose.

LECTURE II.

ELECTRO-PHYSIOLOGY.

ELECTRO-PHYSIOLOGY is a subject of such extent and intricacy, that it is not a little embarrassing when there is such brief space for its consideration, to decide what method of presentation will best illustrate its value as a guide to the study of electro-therapeutics.

Animal electricity, although interesting and instructive, I shall not attempt to elucidate here. The most that I shall attempt will be: 1st, To state some facts (all of which I have myself verified) in relation to that peculiar modification of irritability that nerves and muscles undergo when acted upon by the galvanic current. 2d, To consider the action of the galvanic current on the brain, spinal cord, great sympathetic and pneumogastric. 3d, Its action on the nerves of special sense. 4th, The action of both the faradic and galvanic currents on the voluntary and involuntary muscles. 5th, Their effects on nutrition.

1st, *Electrotonos.*—When, by means of two electrodes, the galvanic current is applied along the course of a nerve, that portion between, as well as a limited portion outside the poles, are said to be in an electrotonic state, and that part of the nerve not included between the poles will deflect the needle of a delicate galvanometer. In other words, there becomes manifest a modification of the natural nerve current.

When the galvanic current and the nerve current flow in the same direction, the strength of the latter is increased, while its strength is decreased if the electric current flows in an opposite direction.

There are two modifications of the electrotonic condition, termed, respectively, anelectrotonos and catelectrotonos. *Anelectrotonos* is a condition of diminished irritability taking place at and near the positive pole or *anode;* while *catelectrotonos* is a condition of increased irritability taking place at and near the negative pole or *cathode.*

Somewhere between the poles, there is a part called the *neutral point*, where anelectrotonos meets catelectrotonos. If the strength of the current is medium, the neutral point is found midway between the poles; if the current is weak, the neutral point is nearer the positive pole; if it is strong, nearer the negative pole.

When an irritable nerve is brought under the influence of a rapidly interrupted galvanic current, the nerve-current gradually diminishes in strength until it is finally destroyed. Nothing is better established in physiology than the above fact; and yet, paradoxical as it may seem, when a nerve, through injury or disease, has quite lost its irritability to the faradic current, it frequently regains it after several applications of the galvanic.

In addition to these phenomena, due simply to the current passing in a *single* direction, we have other physiological effects, due to changes in the current, caused by closing, breaking or reversing. When the electrodes are applied to a nerve, and the current closed, we observe a momentary contraction, proportionate in vigor to the tension of the current. While the current is flowing continuously, no contractions take place; but immediately on breaking the circuit, if the current be not too weak, muscular contraction again occurs.

The following is the statement of what physiological experiment has taught:

1st. The mildest currents applied to a nerve cause contraction only on closing the circuit, independently of direction.

2d. Currents of medium strength cause contraction both at the opening and closing in both directions.

3d. Strong descending currents cause contraction only at closing the circuit, while strong ascending currents cause it only at opening.

Although it is impossible to illustrate these laws by experiments on the living man, they can be readily verified on the fresh nerve of an animal. In experimenting on oneself, or on others, the strongest current that can be well borne, produces the effect only that follows the application of a very mild current directly to the nerve—viz., contractions only on closing the circuit independently of direction. Another effect of electrotonos is the change of irritability which is caused by a change in the direction of the current. If a nerve is subjected for some time to the influence of a galvanic current in a certain direction, it loses some of its irritability, which it regains when the current is reversed. One noticeable result of the passage of the *continuous* galvanic current through an exhausted nerve is the marked refreshing effects which follow; the nerve is, for the time, restored to its usual tone and level.

2d, *Action of the Current on the Brain, Spinal Cord, &c.*—It has been shown by Fritsch and Hitzig, using the galvanic current, followed by Ferrier, using the faradic, that there are centres in the cerebral convolutions for the production of voluntary muscular movements in various parts of the body. In these experiments, the applications were made directly to the substance of the brain; and interesting as they are, and as worthy of study, the practical gain to electro-therapeutics through such investigation amounts to but little. As practical men, we are most interested in knowing what external applications will accomplish. Physiological experiment has simply taught us, and clinical experience has confirmed the teaching, that very mild currents of galvanism, when externally applied, will directly, and not alone by reflex action, affect the brain. If it were possible in our treatment of diseases of the nerve-centres, to localize the action of the current, it can readily be seen what increased facilities would be ours in dealing with certain pathological conditions. This, unfortunately, we cannot do; but as clinical experience has shown very conclusively the excellent results that follow simple external applications, it remains for us to utilize, so far as possible, this method.

When we come to consider the action of electricity on the spinal cord and sympathetic, we find that there is ample ground for speculation, and room for a wide diversity of opinion. It is no very difficult matter to expose the spinal cord in the living animal, and to show that the direct application of galvanism is sufficient to throw the muscles of the trunk and of the extremities into violent contractions. It is as easily demonstrated that if the cord be traversed for some time by the current, that portion which is under the electrical influence, finally becomes insusceptible to all forms of stimulus, mechanical or electrical. A so-called inhibitory effect is produced. Finally, it is agreed, that when the faradic current is applied directly to a certain portion of the cord near the sixth cervical vertebra (centrum cilio-spinale), the excitation is transmitted to the cervical sympathetic nerve, and thence to the radiating fibres of the iris which it animates; similarly, by electrization of that part of the cord which traverses the fourth lumbar vertebra (ganglion genito-spinale), it is possible to induce very appreciable contractions of the vasa differentia, the bladder and rectum.

It is exceedingly difficult, however, to determine just to what extent it is possible to affect the spinal cord in the living man, by simple external applications. Yet, that it can be directly influenced and brilliant therapeutic results obtained, has been sufficiently attested. The cilio-spinal centre just mentioned is between the sixth and seventh cervical vertebræ, as can be demonstrated by external applications both of the galvanic and faradic currents, and is of great importance in general faradization. To a certain extent, yet not so decidedly, the ganglion genito-spinale can be directly affected—at least, by the galvanic current.

The effects of electrization on the exposed sympathetic nerve are so familiar as scarcely to need mention. In brief, it has been observed time and time again, that the condition of redness and injection of the conjunctiva, ears and nostrils, contraction of the pupils, secretion from the mucous surface of the eyes, &c., that follow division of the cervical filaments of the sympathetic nerve, entirely disappear when the cephalic extremity of the cut nerve is submitted to electrization. The effect, therefore, of direct galvanization of the cervical sympathetic is to contract the arterioles, through the medium of the vaso-motor nerves. Galvanization of the inferior cervical ganglia of the sympathetic, as well as of the superior thoracic ganglia, accelerates the heart's action, while powerful galvanization of the six lower dorsal ganglia, and the splanchnic nerves to which they give rise, diminishes the peristaltic action of the intestines. Mild galvanization, on the contrary, has been found to increase the peristaltic action.

The effects of direct electrization of the *pneumogastric* vary with the strength of current used. If strong faradic currents are employed, coughing and vomiting are the result; while currents of medium strength produce sudden inspiration and forced expiration. Arrest of respiration is liable to be the result of galvanization of the laryngeal branch of the pneumogastric.

In attempting now to consider the effects of external applications to the sympathetic and pneumogastric of the living man, the same difficulty confronts us, as in the case of the brain and spinal cord. We cannot accurately localize the current in these nerves or any of their ganglia. A current of sufficient strength to appreciably affect the cervical sympathetic, necessarily at the same time influences, more or less, the pneumogastric, the depressor nerve and the cord.

The effects of external galvanization of the sympathetic are not altogether uniform, but many trials have shown that a very constant effect of this method of operation—one electrode being placed in the mastoid fossa, and the other over the seventh cervical vertebra, is a slight and occasionally a profound feeling of drowsiness, together with a feeling of warmth through the system, accompanied by perspiration, and a decided effect on the pulse. In several cases, I have observed profound sleep, induced within a minute from the beginning of the application. The eyes would close, the head would drop and nod, and when the electrodes were removed, the transition from drowsiness to a wakeful condition would be slow, very much the same as is observed when one is awakened from a deep and natural sleep. In other cases, on the removal of the electrodes, the person would awaken immediately and become fully alive to his surroundings. These different phenomena were, of course, the result of varying idiosyncrasies. If we accept the theory that in sleep there exists a condition of cerebral anæmia, it is not difficult to believe that the slight feeling of drowsiness that so frequently follows galvanization of the sympathetic, and even of the brain, is in part, at least, due to a diminution of the blood supply. At all events, this result, which is so grateful and restorative in many nerve disorders, is constantly achieved in the experience of every practically competent electro-therapeutist.

3d. *Action of Galvanism on the Nerves of Special Sense.*—The galvanic current, applied so as to affect the retina or optic nerve, either directly or reflexly, causes flashes of light and perception of color. The faradic current, according to the method of its application, when applied in the ear, causes a humming or rumbling sound—due in part to susurri of the muscles.

The auditory nerve reacts to the galvanic current by certain fixed laws, which, although interesting, and to a certain degree instructive, cannot be considered here. It may be said, however, that the auditory nerve reactions harmonize with the law of electrotonus and Pflüger's contraction law as already enunciated.

On the gustatory nerve, the action of galvanism is to cause a metallic taste more or less marked. The perception of the metallic taste is frequently an important aid as a guide in the treatment of cases.

On the olfactory nerve, the action of the current is less marked, but the negative pole of a strong galvanic current, when applied to the Schneiderian membrane, is followed by an odor somewhat resembling sulphuretted hydrogen. While only the galvanic current exercises a constant and uniform influence over the retinal reaction, in certain sensitive conditions, the faradic current produces unmistakable flashes of light; and when the apparatus is constructed so as to give forth certain qualities of current, as in the continuous coil machine, these glimmerings are peculiar and brilliant.

4*th*. *Action of Electricity on the Voluntary and Involuntary Muscles.*—Contractions of voluntary muscles are induced in two ways: 1st, By acting on the motor nerve. 2d, By acting on the muscle itself. In the latter case, it is simply necessary to place the electrodes at either end of the muscle, when, through excitation of the muscular and intra-muscular nerve fibres, contractions more or less powerful take place. By this method we obtain contractions only of that muscle, or that portion of muscle, included between two poles. By pursuing the first method, however—placing one pole over the point where the motor nerve is most superficial, and the other over the muscle or muscles supplied by its branches—we not only obtain stronger contractions, but, at the same time, influence every muscle to which the nerve terminals run.

These motor nerve points are of much importance, especially in carrying out the details of localized faradization in the treatment of paralysis, and have been thoroughly studied by Ziemssen, who experimented on the recently dead subject, and marked with nitrate of silver the points at which the individual nerves and muscles most readily responded to faradization. With a fair knowledge of anatomy, however, any one, by a little experimentation on himself or a friend, can readily obtain sufficient information for most of the purposes of therapeutics. In this investigation, one large moistened sponge electrode should be firmly placed on some indifferent point, and a small negative electrode, as large as a silver half dollar, pressed near the point where the nerve is supposed to issue from the muscle. If the right point is touched, the normal physiological action of the part affected will at once appear. It is impracticable here to give the situation of all the motor points in detail. Those who wish for helps to aid them in prosecuting this study will find in Ziemssen's *Die Electricitat in der Medicin*, a most complete array of illustrations of the motor points. The following, however, are the situations of some of the most important:

Facial.—At its exit from the stylo-mastoid foramen, between the mastoid process and the angle of the lower jaw.

Pneumogastric.—At the lower and anterior part of the neck, between the common carotid artery and the jugular vein.

Phrenic.—At the outer border of the sterno-cleido-mastoid muscle near its junction with the clavicle.

Brachial Plexus.—In the supra clavicular space, posterior to the outer border of the sterno-cleido mastoid muscle.

Median.—In the lower third of the arm, at the point where it crosses the brachial artery.

Radial.—In the lower third of the arm, at the point of its emergence from beneath the triceps.

Popliteal.—On the posterior border of the capitulum fibulæ.

Tibial.—On the middle and outer part of the knee, and also in the depression posterior to the internal maleus.

Involuntary Muscles.—The action of electricity on involuntary muscular fibre is quite different from that on voluntary muscles. In the latter, contraction takes place immediately on closing the circuit. In the former, movements are not induced until a certain time after the tissue has been acted upon. In the case of voluntary muscles, after the removal of the excitation, all contraction ceases, while with involuntary muscles, the movements that are excited by electricity continue for a long time after the cessation of the current.

The transverse and longitudinal fibres of the *stomach* are readily influenced by either galvanization or faradization; and in a number of instances have I had occasion to observe the readiness with which this phenomenon is demonstrated in the living man, by applications directly to the mucous surface of the part. If the current is applied to the intestines of an animal recently killed, contractions take place in the physiological direction of the peristaltic movements, until their calibre is nearly closed. These effects are induced in a less degree, by external applications, or by the introduction of one electrode in the rectum, and partly explains great value of electricity in the treatment of constipation.

When the *bladder* is subjected to electrization, a visible drawing and contraction take place, and its cavity diminishes. In cases of paresis and paralysis of the bladder, the value of this treatment has been often shown.

The *uterus* also contracts very much after the manner of he intestines, whether it is or is not in a gravid condition. The practical application of this physiological fact is seen in the benefit that accrues from the use of electricity in uterine engorgements, in menorrhagia, enlargements, &c.

The iris, spleen, ureters, vas deferens, epididymus, tunica vaginalis, gall-bladder, œsophagus, heart and blood vessels are also more or less susceptible to the influence of electrization.

5th. Nutrition as affected by Electricity.—The effects of electricity on nutrition are exceedingly complex; but in the light of a somewhat extended clinical experience, I can confidently assert that, as a result of its varied physiological effects, we obtain tonic results of a most decided character.

Up to the year 1866, it was generally assumed that the main, if not the only action of electricity, was that of a stimulant. Soon after this, in a number of papers in the *New York Medical Record*, by Dr. Beard and myself, the idea of the tonic action of electricity was first enunciated, and the method of general faradization, by which this effect is best obtained, was fully described.

The influences that aid nutrition and thus produce tonic effects, are four, viz: mechanical, physical, chemical and physiological; and although all enter more or less as factors in bringing about constitutional tonic effects, yet the mechanical and physiological actions are mainly efficacious.

The mechanical effects are most markedly appreciated under the faradic current, as is quite evident from its nature. Physiological effects are produced by either current, although the galvanic frequently acts most powerfully here, and espe cially in exciting the process o absorption. By it, the se cretions may either be increased, diminished, arrested, or their quality modified. The usual effect is to increase both secretion and excretion; but when *very mild* currents are used, their activity is not always increased, and experience teaches that in the healthy organism *very strong* currents may produce a partial arrest of these functions. Very interesting effects of electricity become apparent when applied in certain pathological conditions. In menorrhagia, instead of increasing the flow, its tendency is to decrease it. In enuresis it acts powerfully in decreasing the excessive waste; while in suppression of urine, some very remarkable results have been recorded. The spermatic fluid is increased by galvanization, as is also the secretion from the sweat glands.

The whole subject of the relation of electricity to nutrition is of immense importance, and I regret that I have neither time nor space to thoroughly consider it. I will merely add that the effects of the faradic current are very powerfully illustrated in the person of those who are constantly (by the method of general faradization), applying it through their own persons. In this way the current passes through both arms and vigorously contracts the muscles, causing a marked and rapid development.

LECTURE III.

ELECTRO-DIAGNOSIS.

The art of electro-diagnosis has been subject to more or less investigation for many years; but only until lately has it assumed a position of importance in practice. This is owing to the labors of a number of careful observers, who have suggested and verified certain uniform polar reactions on the healthy nerve and muscle. By *polar reaction* is meant the measure of muscular contraction that follows the application of the positive (anode) or negative (cathode) pole to a nerve or muscle.

In hastily considering this department of my subject, I can only refer to some of the principles on which electricity is used as a means of diagnosis in medicine. The success and satisfaction with which special applications of these principles are made, will depend upon the thoroughness of after observation and experience. Now, although contractions occur only on closing or opening the current, yet we distinguish four kinds designated by the following abbreviations 1st. C. C. C.; 2nd. A. O. C.; 3rd. A. C. C.; 4th. C. O. C.

The first is the *cathodal closure contraction*, and occurs when the cathode, or negative pole, is applied to the nerve or muscle, and the current closed.

The second *anodal opening contraction*, occurs when the anode or positive pole is applied to the nerve or muscle and the circuit opened.

The third *anodal closure contraction*, occurs when the anode is applied and the current closed.

The fourth *cathodal opening contraction*, occurs when the cathode is applied and the current opened.

The readiness with which these various contractions are induced relatively to each other, depend altogether upon the strength of the current, and the condition of the nerves, whether diseased or healthy. If on the healthy nerve or muscle, the negative pole is pressed, and a current of sufficient strength employed, it will be found, that on closing the circuit, a contraction takes place. In order, however, to induce a contraction of the same vigor on opening the circuit, it is necessary that the strength of the current be increased. Each one can readily confirm this statement for himself, and by experimenting thoroughly, it will be found that contraction in the healthy muscle occurs in the order just given.

In diseased conditions, however, this formula is subject to great variations. The readiness with which a muscle contracts to electrical influences may be increased. This occurs in certain cases of hemiplegia associated with an irritative lesion; and in the early stages of facial paralysis due to the action of cold associated with a rheumatic diathesis. In these cases, the intra-muscular nerves are attacked from the beginning, while there is but little if any alteration of the muscular fibres. The faradic current causes contractions through the intra-muscular nerves; therefore in cases such as the above, its power to produce muscular contractility is lost. The galvanic current acting more especially on the muscular fibres, retains its power, and, as experience shows, a milder current will cause contractions than is found necessary for the healthy muscle. As the patient improves, it takes an increased tension of galvanism to cause the same effects, until finally farado-muscular contractility becomes manifest. Again the readiness of contraction may be decreased and finally abolished, as in the late stages of bulbar paralysis; occasionally in paralysis following acute diseases, in myelitis and in progressive muscular atrophy.

The above are termed *quantitative reactions*, consisting, as has been stated, in a simple increase or diminution in the quickness of response to a current of given strength. Qualitative, which includes as well quantitative changes—in other words termed the "*Reaction of Degeneration*"—consists in an alteration in the order of occurrence of the contractions.

These changes are observed in any form of traumatic paralysis, where the continuity of the nerve has been completely interrupted; in rheumatic paralysis associated with compression at some point of the nerve; in lead palsy; many forms of infantile paralysis; in spinal paralysis where the grey matter is much involved; in progressive muscular atrophy; in some cases of neuritis; bulbar paralysis; in cases of pressure on the nerve by tumors or cicatrices, &c., and in some paralyses the result of acute diseases.

The normal formula becomes, in the above cases of paralysis, subject to the following changes: The negative pole at its closure (C. C. C.) may act even less readily than the positive (A. C. C.); and the positive pole at its opening (A. O. C.) has less effect than the negative at *its* opening (C. O. C.) At the same time the contractions become weaker and less rapid than in health. When the circuit is closed, the contractions are also liable to become tetanic, while rapid interruptions of the galvanic current utterly fail to call forth any response.

By the same principle which has been our guide in the enunciation of the preceding diagnostic signs, viz.: the fact that the electro-muscular contractility is more or less modified by disease—we may also utilize the currents for the detection of malingerers and for deciding between real and apparent death.

By recollecting again that all parts and organs of the body are more or less sensitive to the electric current, and that this sensitiveness is modified by disease, we are oftentimes enabled to point out the seat of derangement, although the special nature of the disorder must be determined by the ordinary means of differential diagnosis at our command.

LECTURE IV.

METHODS OF APPLICATION.

As the generic term—electricity—includes every manifestation of this force, so by the term electrization we understand every form and detail of its application in medicine. The wide attempts to popularize the use of this remedy during the last decade have been eminently successful; but, in great measure, this success has been at the expense of a clear conception of the principles and methods involved. Both the profession and laity are accustomed to speak of "trying electricity," as if its use called for no more knowledge or experience than the manipulation of a child's toy. Patients are recklessly and indiscriminately recommended to purchase batteries, and have the applications made by themselves, their friends, or servants. Benefit may, indeed, sometimes follow these blind procedures, but, as a rule, injury of a three-fold character results. In the first place, we note an injury of a negative character, so-called, but none the less real, in that the patient receives no benefit from an agent which, rightly used, might have done good. Again, the physician injures himself in failing to help the patient; and lastly, he injures the profession by making it appear that the medical use of electricity is a simple and trifling thing, and therefore the peculiar province of ignorance and charlatanism. It is not too much to say that skill and the requisite knowledge in this special branch, comes only by close observation, hard study and much experience. As we have said elsewhere, the duty of the profession in regard to this matter is very clear. They should familiarize themselves with electro-therapeutics, so as to make the applications themselves, or through trained assistants, or they should refer the matter to those who are masters of the subject. In case neither of these courses is practicable, they should, as a rule, not attempt to have electricity used at all, or should confine themselves mainly to its use as a palliative, and with the understanding that they are submitting to a necessary evil.

The main methods of electrization are four in number—viz., 1st, Localized Faradization; 2d, Localized Galvanization; 3d, General Faradization; 4th, Central Galvanization. These are, of course, subject to infinite variation in the practical details of their application; but a general description of each may prove sufficient as the foundation-stones on which to build experience.

Localized Faradization.—The art of limiting the excitation of the faradic current to certain organs and tissues, is, in the main, due to Duchenne. He called attention to the fact that electricity could be localized *under* the skin, if moist electrodes were firmly pressed upon the skin. He was led to this observation by the very familiar phenomena that follow the application of the dry electrode or hand to the surface of the body—viz., a crackling sound, but no sensation and no muscular contraction. This is due to the very slight conductivity of the skin. Through moisture, however, its conductivity is increased, and he observed that when wet electrodes were applied, the same strength of current excited contractions immediately.

This system, simple in its origin and detail as it may seem, has been refined and developed until it has grown into a permanent department of science. To be proficient in its use, demands a certain degree of anatomical and physiological knowledge and manual facility; but its successful employment requires neither the dexterity nor care that is exacted by localized faradization, general faradization and central galvanization, nor the time and patience demanded by the two last named methods.

For these reasons, localized faradization has been generally adopted by the mass of the profession, to the exclusion of the more advanced processes, by which alone we can fully utilize the therapeutic powers of electricity. In carrying out the details of localized faradization, the situation of the motor points should be carefully studied. Ignorance of these points will involve waste of time in searching for them with electrodes in hand, and at the same time add to the annoyance of nervous patients. By placing the negative pole over the motor point, and the positive over the belly of the muscle, we obtain immediately the best possible contractions, whether for therapeutic or diagnostic purposes, with the minimum strength of current.

Localized Galvanization, especially when applied for the relief of pain, is a procedure of much greater delicacy than localized faradization. It was introduced to the profession more especially by Remak, in a work "On the Methodical Electrization of Paralyzed Muscles," by virtue of which he became the founder of a school of electro-therapeutics in Germany, as Duchenne had been in France.

The term *stabile* application is employed when both electrodes are kept in a fixed position. The term *labile* application is employed when one or both electrodes are glided over the surface, without, however, causing any interruption of current sufficient to produce appreciable muscular contractions.

When we desire to induce a purely sedative influence, it is often of the greatest importance that the galvanic current should not only be free from any distinct interruption, but that every variation of current influence—such as follows moving the pole along the skin—should be carefully avoided. At other times, however, it is desirable that our applications should be "increasing," by which is meant that the current strength is gradually augmented without removing the electrodes. If the current is thus gradually increased, a much greater power can be borne, than if it is suddenly let on in full force, with the first closure of the circuit. A current which may produce unbearable pain, or, when applied near the nerve-centres, dizziness and faintness, may be borne without discomfort and with positive advantage, if it is gradually increased from the minimum of current strength. Applications to the brain, eye and ear especially, and to the sympathetic spinal cord, urethra, and to all conditions of great irritation wherever seated, should always be thus gradually increased, and in the same way decreased.

With the faradic current, the management of these increasing and decreasing currents is very simple; but to gradually increase the galvanic current, especially if no rheostat is at hand, requires very great care. Most galvanic batteries that are now made, have an arrangement that gradually adds to the number of working elements without interrupting the current; but even with the greatest precision of manipulation, breaks are apt to occur when least expected or desired, and it is far safer, therefore, to be always provided with some form or rheostat.

Labile, or stabile interrupted currents, are generally preferred for the galvanization of muscles, while for the galvanization of the head, spinal cord, sympathetic, nerve-tracts and plexuses—stabile continuous currents—either uniform or increasing, are, as a rule, indicated. In addition to their power to produce muscular contractions, labile or stabile interrupted currents cause more marked physical and mechanical effects, while stabile continuous currents, whether uniform or increasing, produce the stronger, electrolytic and catalytic action. In applying the galvanic current to the brain, it is well to remember that there is less tendency to dizziness if the negative pole is applied first, and the circuit closed and opened with the positive.

There are many special effects of localized electrization, as of general faradization and central galvanization, but the leading and general results of all the methods is improvement in nutrition.

Localized electrization of poorly nourished and atrophied muscles, develops size and increases strength; localized electrization of any organ, such as the uterus, the nutrition of which has become impaired and its size diminished, tends to develop it and to increase its functional activity. In localized electrization, these results are, of course, of a local nature; yet, owing to the fact that absolute localization is impossible, we not unfrequently observe effects extending far beyond the parts actually enclosed in the circuit.

By reflex action, also, we obtain remote effects, which are either desirable or undesirable, according to the demands of the case in hand. Galvanization of the spine, and even of the extremities, may, in certain irritable conditions, excite the characteristic metallic taste. Galvanization, and even faradization of remote and limited areas, sometimes relieves pain, induces sleep, and increases the menstrual and other discharges through reflex influences alone.

The effects of all local, as well as general applications, vary according to the length of the seances. The effect of the faradic current, when first applied by means of moistened electrodes, is to cause a tingling sensation, more noticeable at the negative than at the positive pole. In a short time, the sensation becomes less and less marked, and a sort of anæsthesia is produced, enabling the patient to endure an increasing strength of current with no discomfort.

The galvanic current, unless it be quite strong, or directed over a motor point, at first usually causes little, if any, sensation. In a short time, however, a slight, burning sensation is experienced, rather more keenly felt at the negative pole. This sensation rapidly increases in acuteness, until it may become absolutely unendurable; for, unlike the faradic current, the galvanic has not the same tendency to anæsthetic effects. There are two causes which probably account for this increase of pain as well as of increased readiness of muscular contractions. The first, is the fact, that the conductivity of the skin becomes increased, not only through the moisture from the electrodes, but also through the greater activity of the circulation in the skin under the electrodes; and the second is the increased nerve sensitiveness resulting from the stimulating effects of the current.

General Faradization.—In the administration of general faradization, we employ, as is evident from its nomenclature, the faradic current alone. Its object is to bring the external portions of the body from the head to the feet, and, as far as possible, the internal tissues and organs also, under the influence of the current. The galvanic current may be used in this way as well; but it is so rarely indicated, that I have not included it in the enumeration of the methods of application.

Its chemical and reflex influences are so potent that, excepting in cases of rare and remarkable insusceptibility to influences of all kinds, its effects would prove harmful rather than beneficial. As illustrative of its occasional value, however, administered generally, I may cite a case of disease of the supra-renal capsule (Addison's disease) in which there was a most extraordinary absence of both electro-muscular sensibilitity and contractility. The faradic current was given with a strength far beyond all former experience, producing but little effect, either primary or secondary. The galvanic current, however, proved unexpectedly efficacious. The secretory functions had, to a great degree, ceased their activity, and as a result, the skin was dry and shrivelled. the throat parched, and even the finger nails were so devoid of moisture, as to break on any attempt to bend them. The result of treatment was to so excite the processes of secretion, as to alleviate every symptom; even the nails became perfectly pliant, the bronze color of the skin receded and became several shades lighter, while the strength and power of endurance increased in due proportion. The case was presented before several of our medical societies, and examined by many of the profession—among others by Drs. Austin Flint and Post. By the former, this case was alluded to in a subsequent edition of his work on the *Practice of Medicine.* It assumes importance, not because of any absolute curative powers in Addison's disease, but simply as one of the most perfect illustrations of the remarkable effects that may follow general applications of electricity. After two years of comparative strength and comfort, the man died, and the *post-mortem* revealed the characteristic changes in the capsule of the kidney. The specimen was presented for examination to the New York Pathological Association, and is now in my possession.

It is very seldom that a case is seen where general electrization is indicated, that the faradic current is not sufficiently powerful, either directly or reflexly, to excite the physiological activities; and in the treatment of thousands of cases of chronic diseases, both functional and organic, I have not had occasion in much above a dozen instances to use the galvanic current in this general way. The results of such applications, in many of these forlorn cases, were, however, so powerfully restorative, and, at the same time, are so little appreciated, that this allusion may, perhaps, bring forth fruit in the experience of others.

Now, in order to bring the whole body thoroughly under the influence of the faradic current, the feet of the patient should be placed upon a copper plate, to which the negative pole is attached. The soles of the feet are not at all sensitive to the current, but if the patient is especially nervous or susceptible, the feeling of constriction that is experienced in the ankles as the current passes, and the occasional contraction of the flexors and extensors may become disagreeable and even hurtful. In this case, it will be better to apply the negative pole, by means of a broad, soft sponge near the coccyx.

The positive electrode may be either natural or artificial. The hand is the natural electrode, and those who are able to bear the requisite strength of current through their own persons, and are willing to subject themselves to the fatigue which follows its frequent use in this way, will find it unrivalled by any other form. It is not absolutely necessary that the hand be used, but it can be readily understood that no artificial electrode that human skill can devise, can equal the hand in its flexibility, and the readiness and completeness of its adaptation, to every inequality of surface. In all applications to the head, eyes and face, and in the more general treatment of acutely susceptible patients, and especially hysterical women, I freely confess that in numberless ways I should fail to obtain the same results by any form of artificial electrode. Ordinarily, however, when the applications come to be made along the course of the spine, over the abdomen and lower limbs, the strength of current necessary is too powerful to be passed through the arms of any operator, and fortunately, artificial electrodes answer here as good a purpose as the hand.

In submitting a patient to general faradization, the operation should be with some regard to order. In the first place, the hair being throughly wet, the hand is passed with firm pressure over the entire surface of the head. In treating the forehead, which is far more sensitive to the current than any other portion of the body, the operator should first press his moistened hand firmly over the part, and then make the connection with his other hand on the sponge of the positive pole. The strength of current, when applied to sensitive parts of the body, can be sufficiently regulated by increasing or decreasing the grasp of the positive pole held by the right hand.

An application of the faradic current to the head in many forms of neuralgia, nervous headache and insomnia, if properly given, is capable of affording instant and most grateful relief. There are very few, however, who administer it with any degree of precision and skill, and as a consequence, we witness aggravation instead of relief of pain. The slightest concentration of current in such situations as the forehead, is capable of exciting pain even in the normal condition, while a proper diffusion over a broad surface, with equal and gentle pressure, affords a sensation as agreeable as it is curative.

The back part of the head and upper portion of the spine (cilio-spinal centre) will usually bear powerful applications; and it is an interesting and important fact that applications to this centre will produce far greater tonic effects than when the pole is applied to any one other portion of the body. Care should be taken to avoid all bony prominences, since slight currents in these regions give great pain. Hence, over the scapula, clavicle, sternum, crest of the ilium, tibia, etc., care should be exercised in the moderation of the current. Let the first applications be tentative. Experience will soon teach that there is no remedy, to the effects of which, there is such a varying degree of susceptibility as to this. A glance will not suffice, and frequently careful examination will fail to give information as to the proper strength and thoroughness of the treatment that should be first attempted. Not until the patient is submitted to a careful electrical test, can we be sure that what we might consider very gentle treatment, will not be too severe for the case in hand.

As in the administration of localized galvanization, the current may be uniform or increasing. When the electrode is on the head, cilio-spinal centre, epigastric region, or pressed firmly down on the various motor points and nerve plexuses, the current should be increasing. To make the applications successful, not only in the ultimate good that comes, but also, in that the patient experiences no subsequent weariness, soreness of muscles, or vague but distressing nervous feelings, requires far more care and experience than is generally supposed. On the part of the operator is demanded a certain degree of mechanical dexterity, entire familiarity with the instrument required, a complete knowledge of electro-therapeutical anatomy, a personal acquaintance with the sensations and behavior of all portions of the body under the different electrical currents, and close and patient study of the diseases and morbid conditions in which they are indicated.

General faradization is, to me, absolutely indispensable in the practice of electro-therapeutics. Beginning with the method twelve years ago, and at first confining my manipulations in electricity almost exclusively to it, I have not to this day seen cause to abandon its practice. New and valuable methods of application have been proposed and adopted. Through a better knowledge of its subtile and far-reaching influences, and of the laws which regulate its action, the constant current is indicated over a wider range of neurotic affections, and alone occupies the field of electro-surgery; and yet if I might roughly approximate the relative frequency with which I even now make use of general faradization in its most thorough form, and all other processes of faradization and galvanization, I should say that fully one-third of the cases indicating the use of electricity are subjected to the first named method. There is no one tonic influence in medicine comparable with it in power; there is none to which can be accorded such a wide range of application, and I can only account for its neglect on the part of those who profess proficiency in electro-therapeutics, because of the time and labor requisite for its successful utilization, and the unwillingness of the physician to subject himself or his patient to trouble. Time certainly is required, and tiresome labor; and so far am I from loving labor for its own sake, that were it not that I know from long experience, the impossibility of satisfactorily supplying its place by other methods, I should be among the last to advocate its importance. Althaus, of London, in his work on "Medical Electricity," speaks with some favor of general faradization; but in his estimate of the *rationale* of its operation, and the effects of the current on the operator—and especially when he would practically discard the method, because he conceives it to be inferior to the application of the constant current for a few moments, falls into the natural error of one whose opinion is based on theory alone. It is evident that Althaus has never made even an approach to a satisfactory use of the method.

Central Galvanization.—By central galvanization, we understand that method of treatment, by which the whole central nervous system—brain, sympathetic nerves and spinal cord—are brought under the influence of the galvanic current. To accomplish this, one pole, usually the negative, is placed over the solar plexus, while the other is firmly pressed on the top of the head, and gradually passed over the occiput, along the inner border of the sterno-cleido-mastoid muscle, from the mastoid fossa to the sternum, and from the cilio-spinal centre down the entire length of the spine. For this method, which we first introduced and described a number of years since, is claimed a distinct and important position. The different applications to the head and neck, which have been variously used since the time of Remak, are simply forms of localized electrization; but in central galvanization, as is observed, the poles are so placed that the whole central nervous system is brought under the influence of one pole—usually the positive—without disturbing the other.

One reason that has been offered for rejecting central galvanization, lies in the fear that its relations to electro-physiological laws cannot be fully explained. It is asserted that a remedy, in order to be indicated in any special disease, must have certain well known physiological activities that directly meet or counteract the observed pathological conditions. To a certain extent this is true. For the relief of a dry skin and high pulse, we resort to diaphoretics and arterial sedatives. To reduce the volume of blood in the brain, we have bromide of potassium, and so on; but on the other hand, can any one tell us minutely and satisfactorily why it is that quinine has a controlling influence over the manifestations of malarial poison? Why iodide of potassium tends to eradicate the syphilitic poison? Or, why opium causes sleep? And yet quinine is indicated in intermittent fever; iodide of potassium in syphilis, and opium in insomnia. That we cannot accurately localize the action of the current in limited areas of the brain, has already been stated; but that external applications of the galvanic current penetrate directly to, and appreciably affect it, is thoroughly established, and the sedative and tonic effects that follow, are well known to every one who has intelligently and thoroughly tested the method.

Central galvanization demands a far greater familiarity with the physics of the constant current, and with both functional and structural derangements of the central nervous system, than is possessed by many who essay its use. If there is any one therapeutical process in the whole range of practical medicine that more than another defeats its own legitimate ends through careless and ill-directed or ignorant applications, it is this. As a matter of experiment, we submit a person in robust health, and with no marked nervous susceptibility, to central galvanization. If the current is gradually increased and as gradually decreased, without interruptions, few if any unpleasant sensations are perceived, although ten, fifteen, or even twenty ordinary cells be included in the circuit. The metallic taste is decided, the head experiences a sensation of fullness, and if the experiment be prolonged, or the electrodes small, itching and heat will be experienced at either pole, and on the head (the seat of the anode) a slight pain, of a dull aching character, may possibly be felt. A second person, of increased nervous susceptibility, will experience an exaggeration of all these phenomena, and subsequently may suffer from severe headache. Because of the symmetrical influence which the galvanic current, by the method of central galvanization, exerts on the brain, little if any dizziness is perceived, by even the most sensitive patients; if, however, the current be passed transversely through the head, the so-called falsification of the muscular sense that results through an unsymmetrical stimulation (one pole affecting the right, and the other the left hemisphere), is the occasion of immediate and intense vertigo. In thus transversely galvanizing the brain, the hemispheres are differently influenced, and the result is a disturbance of the equilibrium. This dizziness, as a rule, passes off immediately on the removal of the electrodes, in healthful conditions, and is attended by no harmful results. In certain pathological conditions, however, and signally so when such conditions are associated with those peculiarly impressible nervous organizations that are so familiar, transverse galvanization of the brain is a highly culpable procedure. Let it be clearly understood, then, that, in most cases, this method should be avoided.

I might cite not a few suggestive cases, and not alone in my own experience, illustrative of the importance of this law; but it will, perhaps, suffice if I simply indicate a few guiding propositions.

And first, there is a certain class of patients, that I have just alluded to as being peculiarly impressible, who will in no degree be benefited by passing the current transversely through the brain; on the contrary, if there is mental or physical derangement from any cause, such application inevitably aggravates the existing disturbance. In many instances, there is no outward indication of any such susceptibility, and very frequently the most careful examination will fail to elicit a suspicion of any unusual relation of the nervous system to electrical stimulation. It is only when you come to subject them to the test of actual treatment that idiosyncrasies are manifested, that would not be distinctly revealed by any other method. In two exceptional cases, for example, of which I have record, a current of comparatively feeble tension caused an astonishing excitation of all the nerves of special sense. Sight, smell, taste and hearing were all perverted and exalted; and that these evidences of excitation were not the result of fancy, I thoroughly satisfied myself by unerring tests. In these cases, as in a number of others that enter as factors into the experience that guides these observations, the after effects were only less unpleasant than the primary, and were disagreeably persistent. Now, observe the effects of applications by the method of central galvanization in the same patients. The same tension of current caused a decided metallic taste (but no vertigo and no ringing in the ears), with a slight feeling of fullness about the head—and a persistence in this form of treatment resulted in grateful relief. In consideration, therefore, of these facts, we should ever be watchful for these susceptible cases; and to avoid errors of judgment that might prove unfortunate, we should not presume even on the most extended experience, but should in the beginning pursue a tentative course.

In the second place, we have in cerebral effusion and softening, and especially in cerebral congestion, conditions that call for care in any method of galvanizing the nerve centres. In old apoplectic cases, transverse galvanization of the head has often been used with no unpleasant results; but this certainly is no reason why it should be thus used. There can be no doubt that it might in many instances prove exceedingly hazardous, and I have even seen unmistakable evidence of the ill-effects (in producing dizziness and nausea) of an injudicious application of localized faradization in the neighborhood of the base of the brain and in the mastoid fossa. It is in the consideration of the symptoms of cerebral congestion, however, that we see most clearly the importance of rightly selecting our methods of electrical treatment. To give any direction to the current, excepting a longitudinal one (by which I mean from the summit of the head downward, or from forehead to occiput) is, I believe, not only unphysiological, but, as well, contrary to the teachings of extended and carefully recorded experience.

In this connection, and especially with reference to central galvanization, an exceedingly important practical point arises concerning polar *influence* and *current direction*. Is the position of the poles, or the direction of the current, the more important factor in the production of therapeutical and purely physiological effects? The French school, and notably Legros and Onimus, deny the efficacy of polar influence in exciting physiological phenomena, ascribing them chiefly to current direction. They ascribe anelectrotonic effects to electrolytic action, and to the induction of currents of polarization.

The contraction laws of Pflüger (already given in Electro-Physiology) render it quite possible that in the electrical stimulation of a given nerve piece, the polar influence has more to do with the resultant physiological effects than the direction of the current; and, according to this theory, the relative position of the poles in central galvanization (anode above—cathode below) would seem, on physiological grounds alone, to be chiefly indicated for the relief of symptoms of central origin. Experience, at all events, strongly confirms its propriety. It is very certain that in many conditions, and especially in true neuralgia and spinal irritation, therapeutic effects vary according to the position of the poles. In central galvanization also, few facts are better established in my mind, than that certain conditions, such as cerebral congestion and forms of hysteria, may be injured rather than benefited by what are termed ascending currents; but whether the ill effects are due to current direction or polar action, I am not prepared to say.

The effects of electrization may be divided into *general* and *special*. The *general* effect is that of a tonic, with a tendency either stimulating or sedative, according to the strength, length and method of application, and the character of the morbid condition under treatment. Undoubtedly one of the greatest obstacles that for many years impeded the advance of electro-therapeutics, was the prevailing and incorrect estimate of its position as a remedial agent. It was regarded as more especially a stimulant, and indicated in those conditions calling for an excitant; hence paralysis was the disease, *par excellence*, for which it was used. Valuable as this effect is, it is far less important than the sedative and nutritive effects, which are general or local, according as the applications are general or local. The same principle holds here as with other remedial agencies. The sunlight and cold water bathing impart their full tonic and restorative powers only when the whole body is submitted to their influences; and it is quite certain, that were it possible to localize the effects of any of our internal tonics to a single limb, we should by such method fail to obtain their general therapeutical action. General faradization and central galvanization (the *rationale* of which were considered in our remarks on Electro-Physiology) are manifestly the methods by which we most successfully elicit constitutional tonic effects.

The special effects of electrization necessarily differ with the varying degrees of susceptibility among patients. The usual primary effects of the general and central method, is a refreshed and moderately exhilarated feeling which may last some hours. If there are vague pains, with nervous excitement, the tendency of the treatment is to relieve and soothe. Unpleasant secondary or reactive effects are not generally experienced. In a certain proportion of cases, however, the patient may experience some soreness in the muscles of the upper and lower extremities, and an indefinable nervousness, which soon gives place to a feeling of increased strength and steadiness of nerve. On the temperature, the effect of general faradization is to lower it when it is abnormally high. It acts also as an equalizer, and patients who suffer from cold feet and creeping chills over the body, become sensible of a feeling of warmth even in the midst of a seance. General faradization has very little influence on the normal pulse, but its power to reduce the frequency of the beats when it is abnormally high in conditions of nervous exhaustion, is distinctly marked. In the treatment of such cases, I have in a seance of five minutes frequently noted a fall in the pulse beat, ranging from ten to thirty to the minute. At the same time, the heart's action becomes more regular and stronger.

An almost invariable accompaniment of general faradization and central galvanization, is an improvement in sleep; and as insomnia, more or less marked, is frequently associated with those neurasthenic conditions for which electricity is indicated, this improvement is indicative of the further benefit that will follow. A better appetite and increased power of digestion, although not observed so early in the treatment, is a pretty constant symptom; while through the direct mechanical effects of the current on the intestines, and its influence over the secretory processes, more or less temporary and permanent relief is afforded in constipation. The influence of general faradization over nutrition, is, perhaps, in no way more marked, than in an occasional increase in the size and weight of the body, so rapid and perceptible t the eye, that it need not be confirmed by reference to the scales. Finally, through tendencies, both direct and indirect, to improve nutrition, we observe increased disposition and capacity for intellectual and physical labor.

LECTURE V.

ELECTRO-MEDICAL APPARATUS.

Preliminary to some practical observations on medical batteries, a few words may be said concerning "electro-motive force" and "constancy," topics which, strictly speaking, should have been discussed under Electro-Physics. The strength of current proceeding from any cell, or series of cells, depends upon a cause not very clearly understood, which we term electro-motive force, and this force depends upon the metals and liquid or liquids composing the battery. The Bunsen element, consisting of zinc and carbon, immersed respectively in solutions of dilute sulphuric and nitric acid, have an electro-motive force that may be designated by the numeral 2. The ordinary Daniell element, consisting of zinc and copper immersed in solutions of sulphuric acid and sulphate of copper, yield an electro-motive force represented by 1. These cells, with their various modifications, yield a true, constant current in that they may be used for hours with but little appreciable decrease in current strength It is not so easy to estimate the motive force of cells composed of a single fluid, since the strength of current proceeding from them decreases so rapidly after a comparatively short usage. Zinc and carbon, in a solution of sulphuric acid and bichromate of potash, yield a force represented by 1.4, while the Smee cell, made up of zinc and platinum, in a solution of dilute sulphuric acid, gives a strength of .8.

The great internal resistance offered by the double fluid batteries very much decreases their real working power, and they are not, therefore, as suitable for the purposes of electrolysis as the single fluid cells. It must not be forgotten, however, that the essential quality of a galvanic battery, for purely medical purposes, is constancy, and that this quality is most perfect in the cells with two fluids. The reason for this lies in the fact that single fluid cells have no adequate arrangement for depolarization. To a certain extent, the rough surfaces of the carbon and platinum, in their respective combinations, prevent polarization (a phenomenon due to the evolution of hydrogen and oxygen in the cell), but in an imperfect manner only. Gradually the oxygen collects at the positive, and the hydrogen at the negative pole; a counter current is generated, and, in time, acquires a strength sufficient to completely neutralize the original current. In the double fluid cells, however, a depolarizing substance, such as will readily combine with the hydrogen and retard its deposition on the negative metal, is interposed between the two elements.

The substances that are mainly used in the different constant batteries are sulphate of copper, bichromate of potassium, peroxide of manganese, chloride of silver and nitric acid. Constant batteries are, however, usually large and heavy, and suitable only for the office or hospital; and as practitioners, as a rule, desire portable apparatus, the majority of those manufactured are of a single fluid only, such as are illustrated in most of the accompanying cuts.

Some authorities, while admitting the superiorty of the single fluid cell for electrolytic purposes, go so far as to declare it essentially unfit for medical applications. This assertion I must pronounce a very great exaggeration. In conditions calling for continuous applications of great length, the double cell apparatus, such as Daniell's, or one of its various modifications, is undoubtedly to be preferred; but in the majority of ordinary applications, the single fluid cell, if kept in good order, answers very well. Applications of from five to fifteen minutes are, as a rule, sufficient, and for this length of time the current strength does not greatly decrease. The specialist, however, who is using his batteries through a considerable portion of the day, must have at his command an apparatus which yields a truly constant current, and for him the double fluid cell is a necessity. Electro-motive force, constancy and portability, then, are the three points to be considered in the selection of a galvanic battery. It is to be regretted that it is so difficult to combine in a galvanic apparatus constancy with portability. Gaiffe's chloride of silver battery (Fig. 1), is one of the most perfect in this respect, but its high initial cost is one disadvantage.

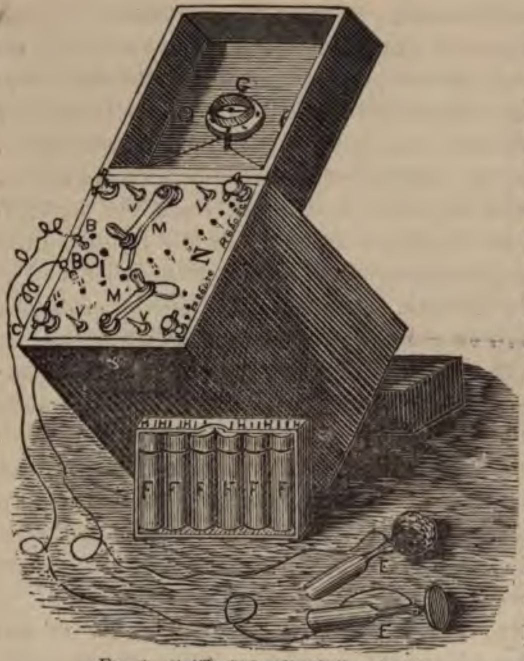


FIG. 1. Gaiffes Chlorid'e of Silver Battery.

In this battery, zinc and silver are the elements; chloride of silver being the depolarizing agent through which the cells acquire their constancy. While the first cost is high, the working is sufficiently cheap, since all of the reduced silver is recovered. A galvanometer (G) is placed in the lid. The cells (F F) are arranged in rows in trays. The weight of this apparatus of 60 cells, is but 15 pounds.

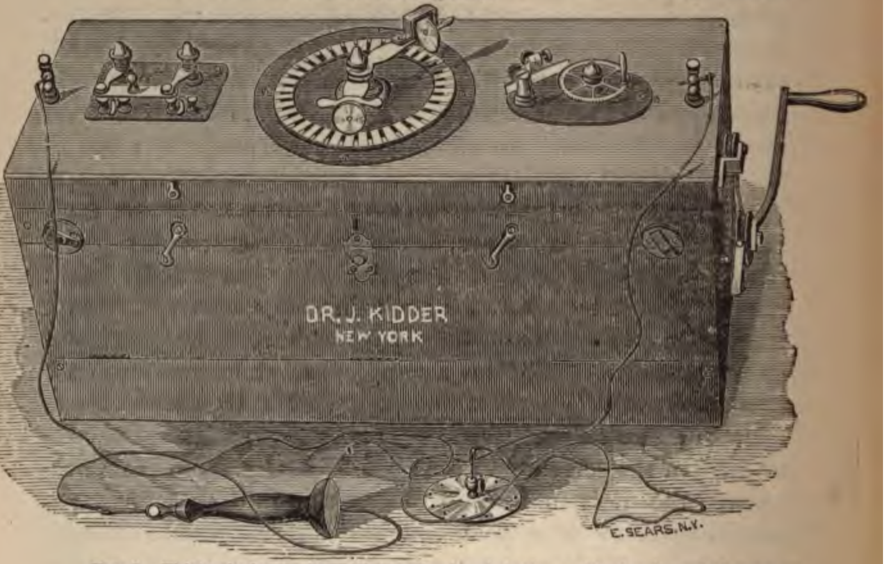


FIG. 2. Thirty-six large zinc carbon cell galvanic battery, with circular switch, reverser and interrupter, for office or hospital use. (Kidder.)

I have used this apparatus (Fig. 2), in my office for some six years. With occasional repairs, it has, on the whole, answered my purpose as well, if not better, than any other single arrangement. By means of the crank on the side, the cells containing the fluid are lifted to the elements and lowered at pleasure. By means of the circular switch in the centre, any number of cells, at the beginning, middle or end of the series, may be included in the circuit, either with or without interrupting the current.

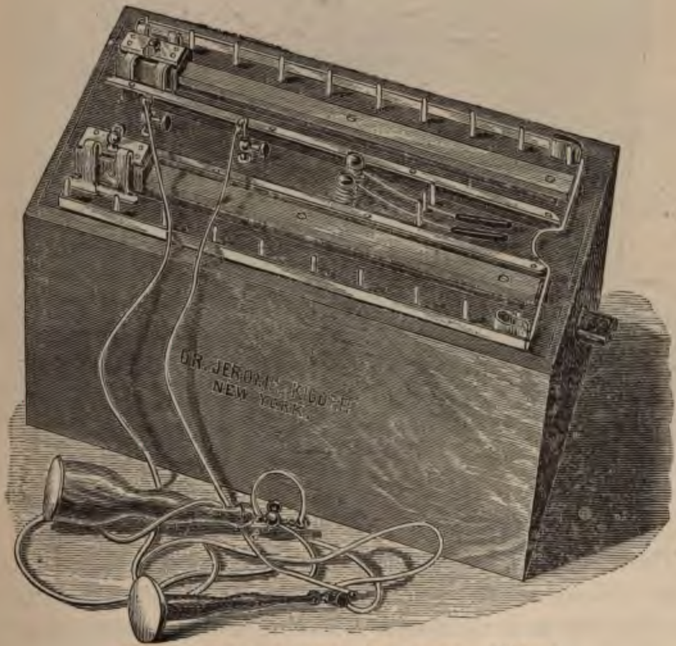


FIG. 3. Eighteen cell zinc carbon battery. (Kidder.)

This battery (Fig. 3), is readily portable, the cells being considerably smaller than those in the preceding illustration. By the slides on the left, the number of elements included in the circuit may be increased without interrupting the current. By locking back one of the springs, the current is interrupted when the slide is moved. By moving the levers on the right of the apparatus, the current can be thrown rapidly and alternatively in opposite directions.

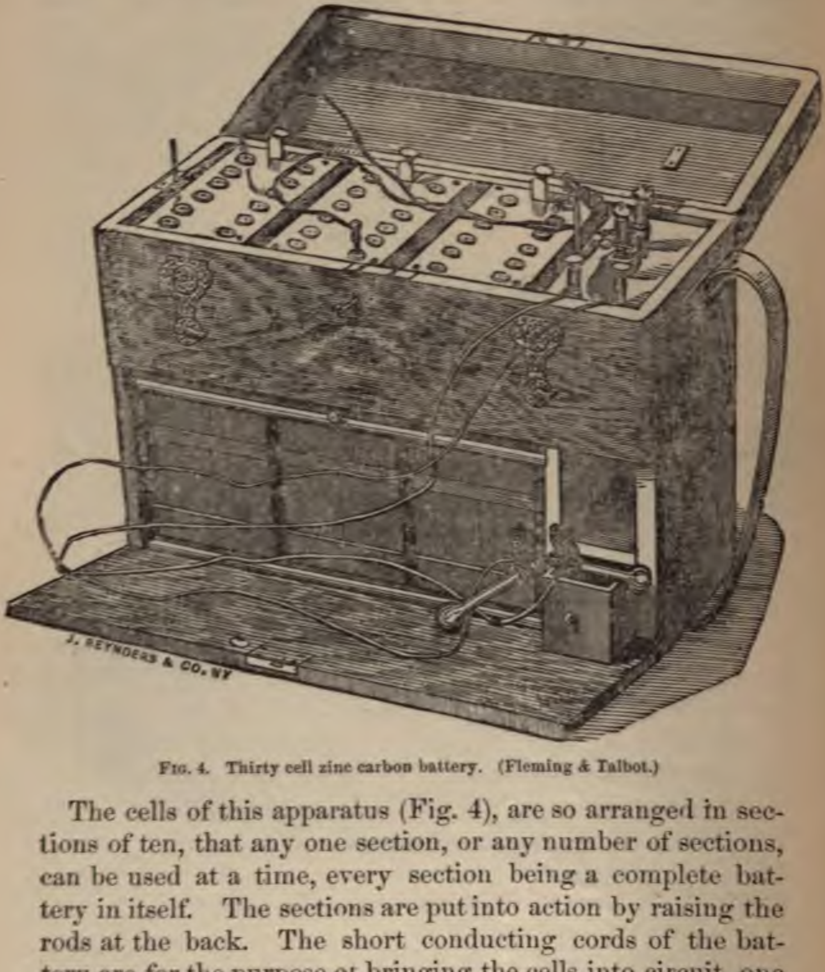


FIG. 4. Thirty cell zinc carbon battery. (Fleming & Talbot.)

The cells of this apparatus (Fig. 4), are so arranged in sections of ten, that any one section, or any number of sections, can be used at a time, every section being a complete battery in itself. The sections are put into action by raising the rods at the back. The short conducting cords of the battery are for the purpose of bringing the cells into circuit, one end of each of them being attached to the posts marked P and N. The other end of the N cord is inserted in the hole marked O, opposite it, and the other end of the P cords is inserted in the holes of the number of cells desired to be brought into action. As it is often necessary to increase the intensity of the current during applications, the P cord is made double, so that while one of its pins is inserted in a certain number, the other pin may be inserted in a higher number, thus increasing the current strength gradually without shock.

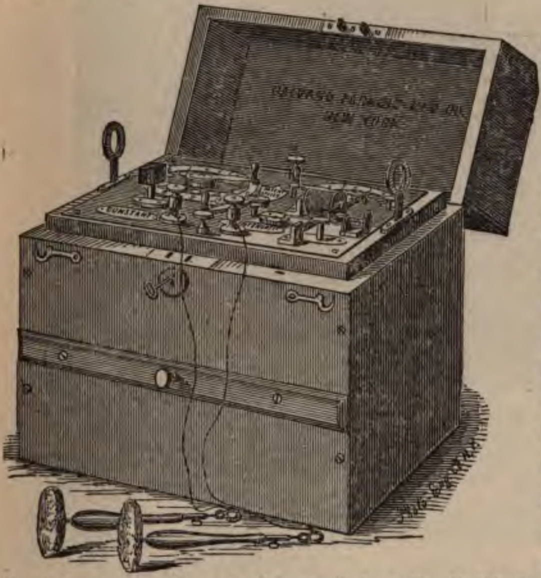


FIG. 5. Twenty-four zinc carbon battery. (Galvano Faradic Mf'g Co)

This is called the Bartlett galvanic battery (Fig 5), and is a very convenient apparatus. It has connected with it a dydrostat, which quite successfully prevents the spilling of the solution during transportation. The accessories, such as current selectors, commutator, rheotome, &c., are all attached. The bottom of the box is a movable tray, in which the glass or hard rubber cells are placed. This movable tray is controlled by two hinged rods, which are fastened to it, and these by two lifting rings at the end of the rubber table. These rings being screwed tightly down, hold the cells firmly against the hydrostat, or being loosened, allow the hydrostat to be removed from the front of the centre of the box; they also serve as handles to lift the tray of cells.

The cells of this battery (Fig. 6), are called the Siemens & Halske, a modification of Daniell's. This cell has a porous diaphragm of clay biscuit, and a packing of papier maché around the zinc. This acts not only as a sponge to hold the solution, thus preventing any spilling; but by increasing the internal resistence, diminishes the quantity of electricity set free. Connected with this apparatus are two current selectors, for bringing any required number of cells into the circuit; a rheotome, for giving slow or fast interruptions to the galvanic current; a rheostat, bringing into the circuit resistances varying from 100 to 16,000 units; the commutator for changing the polarity of the current; the galvanoscope, showing when the cells are giving a current, and a faradic coil, giving electro-magnetic currents. The cells being double, the current proceeding from them is, of course, constant.

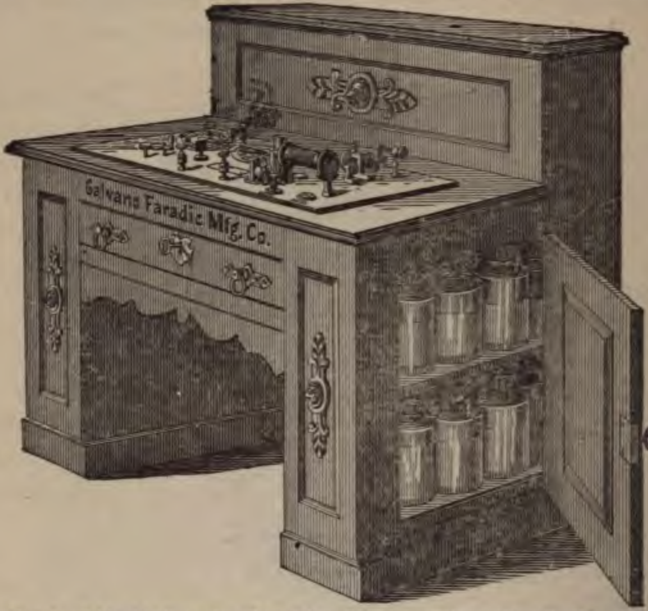

Galvano Faradic Mfg. Co.

FIG. 6. Cabinet battery for office or hospital use. (Galvano Faradic Mf'g Co.)

This apparatus (Fig. 7), is run by a Smee cell. It furnishes induction currents from four different coils of insulated wire, each coil consisting of a different length, thickness and number of convolutions; and these coils are so arranged as to yield a current from any single coil, or from two or more consecutive coils in the combination, thus making in all ten variations in the qualities of the induced current. The principal variations, however, number but four, viz., AB, AC, AD and AE. The conductors are connected with the two front metallic posts, as shown in the figure, and the current from any special coil, or from any combination of coils desired, is elected from the metallic posts A, B, C, D and E, by means of the two switches 3–4, which are insulated from each other at their common pivotal end. The switch 5 (resting on the front post), gives the stronger; and resting on the back post,

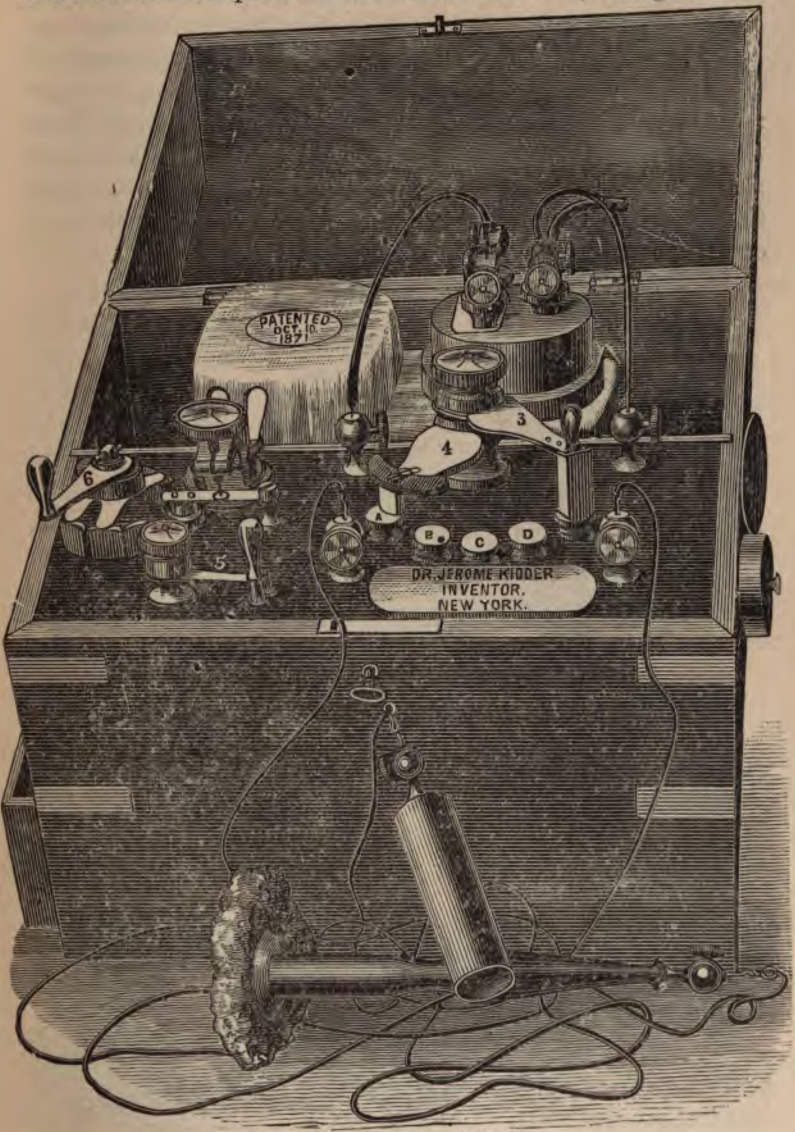

PATENTED OCT. 10. 1871
6
4
3
5
A
B
C
D
DR. JEROME KIDDER INVENTOR. NEW YORK.

Fig. 7. Faradic Apparatus. (Kidder.)

the weaker degree of power, and in each case the power is further varied to any desirable degree by the tubal plunge, the extremity of which is shown at the end of the box on the right. The switch 6 will reverse the direction of any current in use. The spring interrupter is of tempered steel, on which is riveted a platinum plate, to which the current is carried through a platinum pointed screw; underneath the hammer of the spring is a screw, forming a part of the electro-magnet, which screw can be turned up or down, to be out of the way of the hammer when vibrating, and yet be near enough to secure good and regular vibrations.

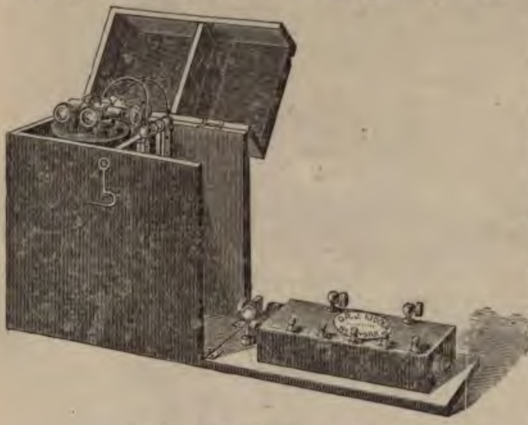


FIG 8. Small Faradic. (Kidder.)

This (Fig 8), is a very compact and convenient apparatus. The helix stands upright in one end of the case, where it is hinged. When the helix is lowered to the horizontal position, as seen in the figure, it becomes connected with the cell in the adjoining compartment, by means of springs underneath the hinges. It is run by a Smee battery.

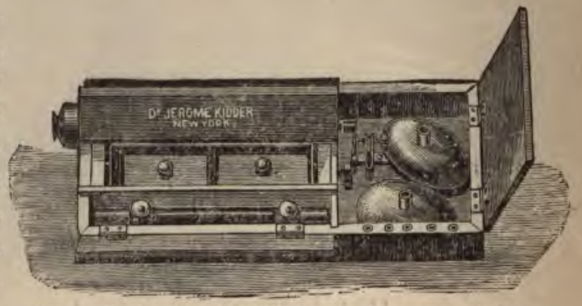


FIG. 9. Modification of Gaiffe's Faradic Apparatus. (Kidder.)

This apparatus (Fig. 9), is sufficiently small to be carried in the overcoat pocket, and in some respects is an improvement on the

French machine. The instrument operates by means of a solution of bisulphate of mercury acting on zinc and carbon, and is, therefore, so far as relates to the motive power, similar to Gaiffe's celebrated machine; but the helix and rheotome are peculiar to the manufacturer's larger batteries. The merit of this apparatus consists in its ingenious combination of old and new ideas, resulting in the construction of an instrument *which, for its size*, yields a current unsurpassed in strength and variation of quality.

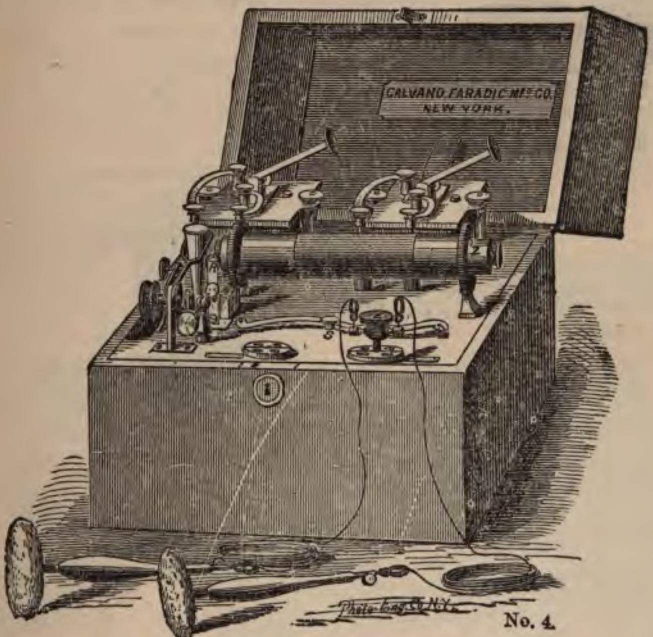

GALVANO FARADIC MFG CO.
NEW YORK.
Photo-Eng.Co.N.Y.
No. 4.

Fig. 10. Faradic Apparatus. (Galvano Faradic Mf'g Co)

This apparatus (Fig. 10), has two cells, which may be united when greater power is desired, or in case one becomes broken or exhausted, the other is in reserve. The elements are zinc and carbon immersed in a solution of sulphuric acid and bichromate of potash. It has the elastic fork, used for giving slow and distinct shocks, as well as quick vibrations at the will of the operator. It has also the usual rheotome attachment by which the current is still further modified.

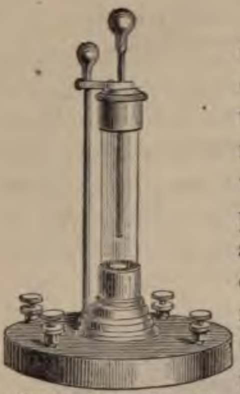
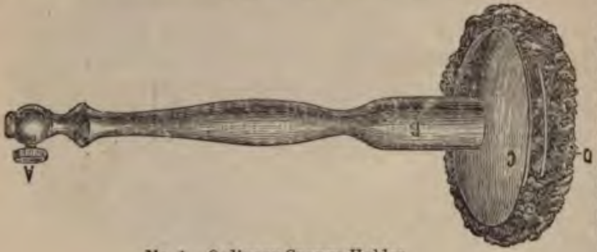


Fig 11 Hydro-Rheostat

This rheostat (Fig. 11) consists simply of a column of water, interposed in the circuit, and so arranged that the distances between the extremities of the metals that close the circuit through the water can be increased or diminished at pleasure. This is a very useful contrivance, and although by no means so precise as the more complicated stopper rheostats, is yet sufficient for many, even the more delicate purposes of electro-therapeutics.

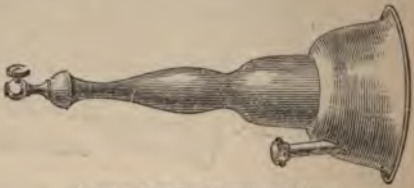
Electrodes.—The following illustrate a variety of electrodes that are useful in practice (Kidder):



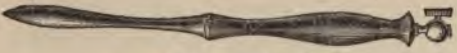
No. 1. Ordinary Sponge Holder.

To fix the sponge on to this holder, unscrew the handle B, by turning the handle itself. Place the sponge on the outside surface of the lower plate D, to bring the edges of the sponge over the edges of the plate; clasp it with the handle C, and hold all together by screwing on the handle B.

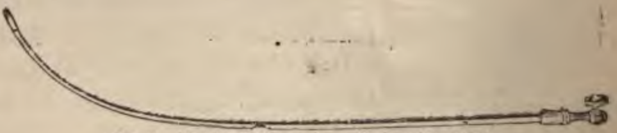
For containing warm water, with clasp holding the sponge.



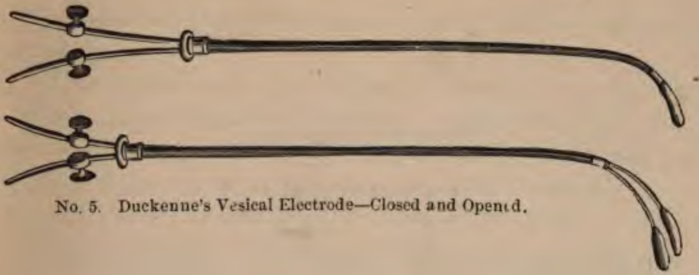
No. 2. Reservoir Sponge Hollow.



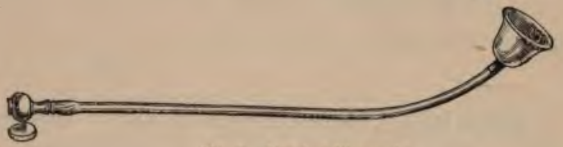
No. 3. Rectal Electrode.



No. 4. Urethral Electrode, with Insulated Tip.



No. 5. Duckenne's Vesical Electrode—Closed and Opened.



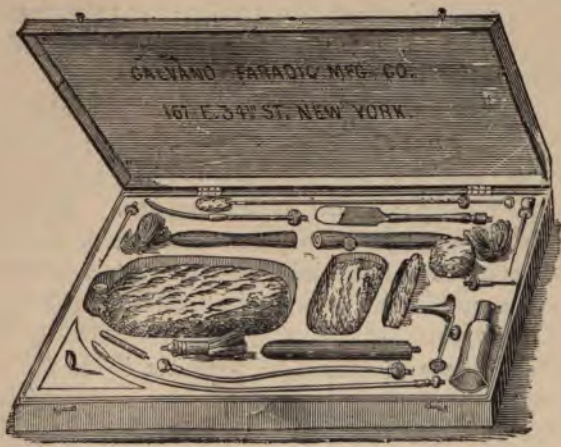
No. 6. Uterine Electrode.

No. 7. Concave Tongue Electrode.

No. 8. Ear Electrode.

No. 9. Scourge, with fine tinsel brush for anæsthesia.

No. 10. Brass Ball for general faradization.


GALVANO FARADIC MFG. CO.
161 E. 34th ST. NEW YORK.

No. 11. This compact case contains the following electrodes: (Galvano-Faradic Mfg. Co.)

1 Controlling Handle,
1 Uniting Handle,
1 Sponge-Covered Foot Plate,
1 No. 1 Carbon Point,
1 No. 2 Carbon Point,
1 Vaginal Electrode,
1 Rectal Electrode,
1 Eye Cup,
1 Sympathetic Nerve Electrode,
3 Olives,
1 Ear Electrode,
1 Tongue-Plate Electrode,
1 Single Nerve Electrode,
1 Cup for Os Uteri,
1 Phrenic Nerve Electrode,
1 Intra-Uterine Electrode,
1 Scourge Electrode,
1 Bladder Electrode,
2 Metallic Discs,
2 Gilded Steel Needles.

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LECTURE VI.

TREATMENT OF SPECIAL DISEASES.

Neuralgia.—The success achieved in the treatment of neuralgia by electricity has been most brilliant. While failures follow the most skillful manipulations, and exacerbations of pain not infrequently result from careless and ill-directed applications, it is safe to say that the great majority of neuralgias, not dependent on serious organic lesion, yield readily to the proper electrical treatment; and in many cases, the distressing pains, dependent on central structural changes are very decidedly alleviated also. The relief of pain is one of the prime functions of medicine; and the question, therefore, as to the form of current best adapted for this purpose is of much importance.

There can be no question that galvanism has a far wider range in this direction than faradism; yet, in consideration of the fact that the latter has been so ignored, it seems necessary to say a word in its defence. My experience will not allow me to doubt that faradism is not only invaluable in many forms of pain, but in certain conditions relieves, where galvanism is not only useless, but worse than useless, since it serves only to exaggerate the existing distress. When, then, a case of neuralgia presents itself for electrical treatment, two questions at once arise: 1st. What form of current is indicated? 2d. What method of application?

True neuralgia, as defined by Anstie, is, without doubt, most successfully treated by galvanism; while hysterical neuralgia and the so-called pseudo-neuralgias, which are simply forms of pain, occupying certain areas, and running seemingly in the direction of certain nerves, yield most readily to faradism.

More specifically, the effects of *pressure* in the various forms of neuralgia are exceedingly useful as guiding symptoms, indicating the proper current. I do not, by any means, lay it down as a universal law, but it will certainly be found that in the great majority of cases of neuralgia, where firm pressure over the affected nerves aggravates the pain, the galvanic current is indicated; while the faradic current has the greater power to relieve, when such pressure does not cause an increase of pain.

In the class of cases called sometimes hysterical hyperæsthesiæ, it is well known that firm and prolonged pressure affords marked relief, while pressure, superficially applied, increases the distress. The faradic current is here infinitely superior to the galvanic. The following case, one of the first that led me to note the significance of this symptom of sensitiveness to pressure, is a good illustration of this general statement.

Case I.—Mrs. S., aged about 60, had for several years suffered at frequent intervals, from a most severe form of facial neuralgia for which she had failed to obtain permanent relief. The associated symptoms were nausea, vomiting, vertigo, and occasionally the pains were so severe as to cause complete loss of consciousness. The pain seemed to start from a point near the right ala of the nose, and thence radiated in all directions—to the temples, eyes, ears and neck. These paroxysms occurred every few days, with occasional remissions of two or three weeks, and lasted from two to six and eight hours. Notwithstanding the severity of the attacks, the affected surface was not at all sensitive to the touch; on the contrary, pressure afforded considerable relief. A mild faradic current, not sufficiently strong to cause decided muscular contractions, was applied (the fingers being used as electrodes) to the point where the pain took its rise, and resulted in an immediate alleviation of pain. The patient was in this way treated from one to three times a week—according as it was convenient—for two months, during which time she had but two slight attacks. From this time, she remained entirely free from them for six months, when they began to recur in a modified form. The same method of treatment was resumed and effectually dissipated all remaining tendency to a recurrence. For three years she has not suffered. In this case, previous to resorting to the faradic, a mild galvanic current was applied, but with no result other than to increase the pain. This experience was repeated, conclusively proving the inadaptability of galvanism to the case.

As a fair example on the other hand of the value of galvanism, I record the following, which has just passed from under my care.

CASE II.—Mr. L., aged 28, of slender build and delicate constitution, was sent to me by Dr. Juan B. de Landeta, of New York. As an employee of the Western Union Telegraph Company, his main labor was in the use of the pen; but he suffered so acutely in his right arm from severe darting and aching pains, that it was feared he would be unable to retain his position. The symptoms manifested themselves in a mild form some six months previously, and had gradually increased in severity, notwithstanding the efforts that had been made to relieve him. Upon examination, I found considerable muscular atrophy just below the spine of the scapula, and extending some distance along the middle and lower border of the deltoid muscle. There were three distinct areas, where pain was pretty constant, viz.: the point where the atrophy began, just below the spine of the scapula; near the external condyle at the elbow; and at the wrist. At these points, pressure always caused more or less pain, and at times this sensitiveness extended the whole length of the arm. Placing the positive pole just above the first point of tenderness on the upper arm, and the negative immediately below the second tender spot at the elbow, I gradually, but without interruption, increased the number of cells included in the circuit, from five to eighteen. After the current had reached this maximum of strength, it was allowed to pass steadily for two minutes, and then the number of cells gradually decreased to one. Removing the electrodes, I now placed the positive pole immediately above the second area of pain, near the elbow, and the negative just below the third point of tenderness at the wrist, and gradually included cells in the circuit to the number of twelve, and after two minutes, decreased the current strength as before. The whole length of the seance, including the process of increasing and decreasing the current was but eight minutes. Improvement was manifest from the first application, and at the present time, after twelve applications administered during the course of a month, the cure is complete.

I have been thus minute in detail since this method of application may be taken as typical of very many that are called for in neuralgic cases. There is no special law as to the number of cells to be used; but it is a very important general law, that the strength of current should not be carried to the point of pain, and as there are such wide degrees of susceptibility among individuals, the current strength necessary, must be determined anew in every case by the physician.

In this latter case, the applications were stabile throughout, for the reason that from the beginning there was manifest improvement, and there was, therefore, no good reason for changing the method. If, however, there had been no benefit, or but very slight, it would have been proper to have used the labile method, thus bringing the whole length of the arm successively in contact with the electrodes. In pursuing this course, the sponges must be pressed with great firmness on the skin, and drawn with a slow, steady and equal motion; for it will be remembered that every change in the position of the poles causes some disturbance of the current analagous to an absolute interruption, and is therefore often contra-indicated in some irritable conditions; and in the case just cited, would, in all probability, not have proved nearly so efficacious as the stabile method.

Chorea (St. Vitus dance).—I know of no disease in which there are stronger indications for the use of electricity than in cases of chorea that have assumed a chronic form. As is well known, the majority of cases occurring in children recover either spontaneously, if proper care is exercised, or through the administration of some nerve tonic; and the test of the obstinacy with which this disease will resist treatment is not so much the severity of the chronic disturbance as the length of time it has continued.

We may meet simply, a slight twitching of the corner of the mouth that has lasted for years and proven itself absolutely incurable; while the most violent paroxysms, associated with frothing at the mouth and inability to articulate, may, under treatment, disappear in a few weeks. It is the readiness with which the ordinary case of chorea tends to recover, quite as much as the efficiency of remedies, that has given such repute in this condition to various medicines, such as iron, zinc, arsenic, strychnia, etc. The surprising lack of unanimity of opinion concerning the treatment of this disease confirms more than anything else this belief in its general tendency to recovery. When, however, a case (be the movements general or local) has continued without amelioration for several months, it may be considered chronic, and will be more or less difficult to cure. In such a case, I regard electricity, in some form, far superior to any and all other methods of treatment, and in other places have reported many recoveries.

The two methods of treatment that in my hands have been most efficacious are, general faradization and central galvanization, at times associated with local galvanization. While the ascending galvanic current is to be preferred in the treatment of chorea located in a single limb or group of muscles, I very confidently assert that general faradization is far more efficacious when the disturbances are general. If the applications are skillfully made, and the seances carefully graduated, it may be made to act both as a tonic, and as a sedative to allay irritability and induce sleep. The following case has been already reported, but as it illustrates more completely the above statement than any more recent example, I venture to give it again.

Case III.—Master N., aged 10, was sent to me by Dr. J. O. Farrington, of New York. Some two months previous to this time, certain abnormal movements, such as starting suddenly to his feet, throwing out a hand or a foot, etc., were observed by the teacher of the boy. Two weeks subsequently, the patient was seized with well marked choreic symptoms of the right side of the body, and in two days the disturbance extended to the opposite side. So constant and violent were the movements of his arms and legs that it was impossible to keep him on a bed or sofa. It was necessary to place him on the carpet, surrounded by inflated rubber bags. Intelligence seemed to be perfect, but the power of speech was lost, and the sufferer made known his wants by impatient cries and ill-directed motions. Sleep was impossible without the nightly administration of an opiate. Contrary to judgment, but by suggestion, I began treatment by the use of a mild galvanic current, directed to the base of the brain and the spinal tract; but this method served only to aggravate the child's condition. I then resorted to the faradic current by the method of general faradization: but so violent were the involuntary movements in the limbs and body of the patient, that it was with difficulty that he could be held in a sitting posture, and his feet kept on the copper plate to which the negative pole was attached. The applications were *general*, every portion of the body, from the head to the feet, being influenced on each occasion. Improvement appeared from the very first. He was at once enabled to sleep soundly, although the opiate was reduced one-third, and after the fourth application, it was dispensed with altogether. In the course of three weeks, during which time fifteen applications were given, the case was so far improved that the patient was able to utter distinctly, words and sentences. The choreic symptoms were so much diminished, that the boy could sit quietly and alone, and during an application was able to command the movements of his body and feet. Improvement continued during the administration of a few more applications, when the child was taken to the sea shore, where in two weeks he quite recovered.

After having enjoyed excellent health for a year and a half, he suffered from a second attack. He was immediately submitted to the influence of general faradization, and recovered more rapidly than before. It is now several years since this last attack, without symptom of a relapse.

Hysteria.—It is generally acknowledged that the various conditions associated with hysteria, such as paralysis, contractures, anæsthesia and hyperæsthesia, are more or less amenable to electrical treatment, either general or local. Hysterical hiccough or cough, aphonia and incontinence of urine, frequently call for localized electrization, although these symptoms may yield under general faradization or central galvanization, no special attention being given to the affected parts.

It is not so well understood, however, that the general disease itself calls for this form of treatment quite uniformly, and in many cases is speedily and permanently benefited. As the disease is constitutional, constitutional treatment is called for; hence general faradization and central galvanization are the methods chiefly indicated. The very remarkable results that may follow this method of treatment are illustrated by the following:

CASE IV.—Mrs. A., aged 30, was brought to me by her friends for the relief of an hysterical condition, unusually persistent and varied in its manifestations. She was the mother of four children, and until within three years, had enjoyed a fair degree of health. She complained of intense neuralgic pains, shifting anæsthesia, indigestion and flatulence, associated with the most profound mental depression, and prolonged paroxysms of violent weeping. She was frequently subject also to violent attacks of screaming, followed by a condition of utter exhaustion, in which the pulse was barely perceptible. There were many other minor points of interest, but the above are sufficient to give an idea of the lamentable state into which this patient had fallen; and taking into consideration the fact that for three years there had been no amelioration, but a slow and steady exaggeration of every symptom, the results of treatment were highly satisfactory. In attempting general faradization, it was found that the patient was so exceedingly sensitive, that the very slightest current was quite unendurable. After several attempts it was abandoned, and central galvanization substituted. A current from six Siemens and Halske's cells excited the metallic taste, increased the flow of saliva, and caused gentle pricking, but no unpleasant effects whatever. In less than two weeks, she had, to a considerable degree, overcome the tendency to depression and weeping, and had not once given way to the disagreeable habit of screaming. At this stage, upon attempting general faradization, it was found that she was able to endure it without discomfort, and it was therefore repeated at alternate seances. Every symptom, including the neuralgia and digestive disorder, improved rapidly, and the patient was discharged within two months, approximately recovered.

Such rapid cures in cases of great severity and long duration are, of course, not every day occurrences; but I have reported a number of cases equally interesting, and notably, one on page 440 of our larger work,* which was, in its details, an almost exact counterpart of the one just related.

Spinal Irritation.—Of the many affections allied to hysteria, spinal irritation is one of the most prominent, and is often associated with it. When it is simply a lesser symptom of hysteria or nervous exhaustion, it cannot claim a distinct

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**A Practical Treatise on Medical and Surgical Electricity*, by G. M. Beard M. D., and A. D. Rockwell, M. D. Wm. Wood & Co., New York, Publishers.

nomenclature, and does not call for special consideration in treatment. When, however, the spinal tenderness and the symptoms that directly flow from it overshadow other accompanying conditions, it claims a place as a distinct disease, and should be treated accordingly. Spinal galvanization, with labile currents in a descending direction, rarely fails to effect a cure. Indeed, there is hardly a disease in which there is so little doubt as to the treatment indicated, and the probable benefit to be derived.

CASE V.—Miss —— was sent to me by Drs. A. E. M. Purdy and F. P. Kinnicutt, of New York, and also by Dr. P. C. Barker, of Morristown, N. J. This young lady was of an exceedingly delicate and sensitive organization, and for a number of years had suffered from spinal irritation, with various accompanying symptoms. The tenderness along the spine was almost continuous, and firm pressure in several special areas caused great pain. The patient complained of palpitation and *breathlessness*, weakness with low spirits and other distressing symptoms which she described as "sinking" feelings—an expression which is sufficiently suggestive to those who have had much experience in this class of cases. There was occasional nausea, with flatulence and loss of appetite, together with sharp neuralgic pains. Very slight exertion caused utter exhaustion. Treatment by the method mentioned above was immediately begun, and with some variation continued for three months. This variation consisted in alternating, just so soon as there began to be a decided diminution of the spinal tenderness, general faradization with spinal galvanization. Amendment began to show itself in a few weeks, and when at the opening of summer, the patient left for the country, she had gained immensely in strength, and was, in the main, relieved of the annoying symptoms that had so long distressed her. Improvement steadily continued, and she is now enjoying as vigorous a degree of health as at any previous time of her life.

Epilepsy.—It would be too much to say that electrization constitutes an essential or even recognized method of treatment in epilepsy. It has been used successfully to oppose certain symptoms which occasionally accompany it, such as tremors, paresis, contractures, etc.; and in slight epileptoid seizures, good results come from stimulation of the peripheral nerves by means of the faradic current.

I have, however, for a long time believed that electricity, either alone or in conjunction with approved methods of treatment, might be more directly efficient in the treatment of this intractable disease. The exact measure of benefit that we may hope to derive from its use, I do not pretend to say. My observations are simply suggestive, and in a late number of the *New York Medical Record* (April 6, 1878,) were given in some detail.

CASE VI.—In one case, that of a child, bromide of potassium was at first given, and pushed until the face was covered with acne. Under this treatment she improved very decidedly through several weeks, and then rather quickly relapsed. I then submitted her to central galvanization and general faradization, alternating the methods and allowing a day to intervene between each application. She improved much less rapidly than under the bromide, but this improvement was retained, and in eighteen weeks from the beginning of treatment, she had quite recovered, as proven by the fact that she has now gone four years without an attack.

CASE VII.—In the second case, no bromide was given by me, but it had been used ineffectually in the past. The man was under treatment two months. The attacks, which had been occurring twice a week, gradually decreased in frequency and severity, until the cessation of treatment. Five months subsequently, the patient called at my office looking well, and stating that he had had no further paroxysm.

CASE VIII.—The third case was an unmarried lady, aged 30. She seemed a confirmed epileptic, since for five years she had suffered from the attacks with increasing severity. Dr. Geo. J. Fisher, of Sing Sing, New York, had the case in hand for a number of years, and had given it thorough and judicious treatment. The bromides of potassium and sodium, of each ten grains, three times a day, she had taken for a long time During the month previous, she had three attacks, and was feeling certain premonitions when I submitted her to the additional treatment by electricity. I did not feel justified in discontinuing medicine, and therefore substituted the following formula:

℞. Potassæ bicarbonatis..............ʒij.
Ammonii bromidi.................ʒvij.
Potass. iodidi........................ʒiij.
Potass. bromidi.....................℥iij.
Infus. calumbæ (British)..........⊙j.
M.—S. Teaspoonful three times a day.

The patient was exceedingly nervous and despondent, and it was evident, that if in no other way, electricity might prove of service as an adjunct to allay irritability, and as a general tonic. I treated her every other day for three months, alternating central galvanization with general faradization. I then gave her an interval of rest for three months, during which time she had an attack occurring about six months from the last. After a second three months' treatment, another interval of rest was allowed, followed by a third series of treatment, continued through three months.

She has not had a second attack, and as nearly two years have passed with but one seizure, we are hopeful of ultimate results. It is worthy of note that after the two methods of treatment were combined, the bromic acne was hardly perceptible.

Exophthalmic Goitre.—Graves' disease, which is supposed to be due to ennervation of the sympathetic, is almost invariably benefited by galvanization. It is to be regretted that the remedy is not more uniformly resorted to in this condition. From time to time, we see in our medical journals records of cases that have been more or less relieved in this way; and abroad, among others, both Ziemssen and Wietfeld have reported many successes. During the past few years, I have treated quite a number of such cases, and while the enlargement of the thyroid gland and the exophthalmia does not by any means always disappear, the violent palpitation which constitutes the most distressing symptom is decidedly and permanently alleviated. My method of treatment is to place one pole (the positive) just above the sixth cervical vertebra, and the other in the auriculo-maxillary fossa, gradually drawing it along the inner border of the sterno-cleido-mastoid muscle to its lower end. A mild current (from five to ten cells) should be used here, and for a short time only, say two to three minutes. Removing now the negative pole to the region of the solar plexus, the number of cells may be increased to twenty, and sometimes even thirty, and the current allowed to pass for several additional moments.

Torticollis (Wry Neck).—This disease, after it has become thoroughly established, is exceedingly obstinate, and frequently, if not generally, resists every form of treatment, surgical included. In its earlier stages, however, it may be cured by electrical treatment alone. The following case illustrates its efficiency:

Case IX.—Miss B., aged 20, was directed to me by Dr. W. W. Jones, of New York. A month previous, she caught cold in the neck from a draught of air while at a concert. For a week subsequently, she would, every few moments, involuntarily turn her head to the right, until finally it became fixed in this position. From the fact that she was not prevented from turning her head, simply from pain, and that when it was brought to the proper position by faradizing the muscles, no pain was caused, we concluded that we had *not* to deal with a common stiff neck resulting from rheumatism, but with tonic spasm of a nervous character. The muscles of the neck on the side towards which the head was turned, had appreciably atrophied, while on the opposite side they were hard and enlarged. These latter muscles exhibited, as usual, increased electro-muscular contractility, while on the right side, towards which the head was turned, contractility was diminished. The above phenomena represent fairly, I think, what are usually observed in the earlier stages of the disease, and the following treatment is typical of what I have successfully employed in a number of similar cases. At each sitting, the muscles of the left side (those that were large and prominent) were submitted to mild galvanization for a moment or so, while the contracted sterno-cleido-mastoid muscle of the right side, towards which the head was inclined, was faradized with sufficient force to cause a relaxation of muscular fibre, allowing the head to turn gradually to its natural position. Upon removing the electrodes after the current had passed several minutes, the head would retain its position without the conscious aid of the patient's will. After an interval of some five minutes, it would again turn to the right. The patient rapidly improved, and after two months of treatment, had quite recovered.

Diseases of the Organs of Digestion (Nervous Dyspepsia).—The results obtained by general faradization, sometimes supplemented by central galvanization, in the temporary and permanent relief of nervous dyspepsia, are often quite remarkable. In this, and in fact in most of the ordinary difficulties associated with the digestive tract, the faradic current is more especially indicated; and one reason is, that it acts more vigorously on the muscles than the galvanic, and therefore produces more powerful mechanical effects, with passive exercise of all the deep tissues. In most cases of nervous dyspepsia, general faradization relieves, not so much by virtue of its influence on the stomach (although it directly affects it), as by its influence on the nervous condition of which the dyspepsia is a symptom.

Constipation and Nausea.—Both the constipation and nausea that are so frequently associated with, and constitute a part of nervous dyspepsia, are disposed to yield rapidly and permanently to electrization. In claiming for this method of treatment peculiar powers in these digestive disorders, it must be borne in mind that reference is made only to that variety dependent upon a special nervous diathesis. In some forms of dyspepsia and constipation, electricity either fails to give great relief, or does so only after the exercise of much patience, or as an adjunct to other remedies. In atonic conditions of these, as well as of other organs, electricity is strongly indicated, and seldom fails to be of more or less service. The following was, in its symptoms, more or less characteristic of those dyspeptic conditions in which electricity achieves its best results.

CASE X.—Mr. A., aged 35, had suffered from digestive disorder for several years. He appeared in good flesh, but every movement indicated a highly nervous organization. When entirely free from all worry and excitement, he suffered comparatively little, and could take food with some degree of comfort; but following even slight mental disturbance, he experienced a feeling of heaviness and pain after meals, more or less nausea and vomiting, flatulence with enormous distension of the bowels, together with the most obstinate constipation. Nothing but complete mental rest would relieve these symptoms more than partially and temporarily; but it was an interesting fact, and one, I think, very rarely observed, that a fifteen-grains dose of hydrate of chloral would uniformly result in at least one free evacuation, and a very great diminution for the time being of the flatulence and distension.

As in this case almost every remedy conceivably appropriate had been laid under contribution, it only remained for me to test the efficacy of electrization. On testing sensation by the faradic current (which in a diagnostic way is far more useful in this disease than the galvanic), it was found that,

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come.

Sequelæ of Acute Diseases.—Electricity is often directly and rapidly efficacious in dissipating the effects that follow certain acute diseases. My own experience in this direction has been confined mostly to the persistent symptoms that frequently result from attacks of cerebro-spinal meningitis, diphtheria and intermittent fever. For the relief of the varied symptoms that follow the first-named disorder, *cerebro-spinal meningitis*, I rely almost alone on central and spinal galvanization. In the paralysis that follows *diphtheria*—whether of the soft palate, vocal cords or extremities—faradization will, as a rule, accomplish everything, although I have met with cases of such severity as to demand the persistent use of the galvanic current. In one notable case, such a profound impression had been made on the sympathetic nervous system, that on every extra exertion, the pulse would rise to 160, and as suddenly sink to less than 60 beats to the minute. In this case, general faradization speedily effected a revolution in the condition of the patient. In *chronic cases of intermittent fever*, when quinine and other tonics have failed to entirely arrest the symptoms, and to build up the system, I have seen undoubted benefit arise from the use of general faradization. It is not claimed that this treatment has any special or rather specific effect on the malarial poison; but that, by virtue of its constitutional tonic powers, and through its beneficial influence over the processes of secretion and excretion, it gives tone and strength.

Diseases of Women.—Almost all the diseases peculiar to women have been treated by electricity, and if the many remarkable results recorded could be accepted as typical of the ordinary effects of electrization, it might be almost considered a panacea for this class of cases. Engorgements and flexions, prolapsus and atrophy, have all, in turn, been treated with more or less success; but in the majority of cases of engorgements and displacements, at least, this success has followed, when the electric treatment has supplemented, and not superseded, other and more thoroughly approved methods of treatment. The rationale of whatever success may be attributed to electrization in certain female diseases, is, at all events, sufficiently clear.

Prolapsus Uteri.—If, in prolapsus, benefit accrues, it is due, in part, to the chemical and mechanical effects of the current on the structure of the uterus, and in part to the tonic effects on the ligaments and vaginal walls.

Engorgements.—The contracting influence of electricity over involuntary muscular tissue, is a strong physiological argument in favor of the use of this remedy in uterine engorgements, and its well-attested power to improve nutrition and develop muscle, recommends its use in uterine atrophy.

Undeveloped Uterus.—In two cases of this class that were examined, both before and after treatment—one by Dr. Fordyce Barker, the other by Dr. T. Addis Emmet—the results of applications directly to the organ were very decided.

CASES XI and XII.—Miss H., aged 35, had suffered from lifelong irregularity of menstruation, accompanied by much pain. The case was carefully examined by Dr. Barker, and his measurement, which I subsequently verified, found the uterus to be but one and three-fourths of an inch in length. After thirty intra-uterine and intra-vaginal applications with the faradic current, extending through four months, a second when applied very mildly, it caused a peculiar and unpleasant sensation in the epigastric region; and yet pressure alone was not disagreeable. In passing the electrode down the spine, a "sinking" sensation was experienced; and when one electrode was applied to the cilio-spinal centre, a decided feeling of nausea followed. These phenomena I regard of importance, since they are very frequently met with in the various manifestations of nervous dyspepsia.

The patient was at once submitted to general faradization in its most thorough form. The immediate result of the application was considerable faintness and nausea, which did not pass entirely off for over an hour. Two days subsequently, when seen again, the patient reported a most remarkable change. The bowels had moved freely, passing also a great quantity of gas, and resulting in an almost complete disappearance of the distension. These symptoms had, however, returned in somewhat less force, when he presented himself to renew the treatment. A second application resulted in similar relief, followed by a return of symptoms, but of much less severity than usual; and in this way the case progressed until after having received twenty-five applications, the tendency to these recurrences seemed to be almost entirely overcome.

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In the case examined by Dr. Emmet, substantially similar results were obtained as regards development. The associated symptoms were amenorrhœa with profound mental depression. As the uterus developed, the menses returned, and the condition of mind improved.

The diseases of women, however, for which electricity has been most frequent successfully used, are amenorrhœa, dysmenorrhœa and menorrhagia.

Amenorrhœa.—In offering a favorable prognosis in any given case of amenorrhœa, it is assumed that no serious pathological condition exists. In cases associated with, and more or less dependent on, anæmia or chlorosis or nervous exhaustion, the important thing is not to specially stimulate the uterus, but to change the constitutional condition, which is the cause of the suppressed function. Accordingly, the treatment by general faradization, combined with such internal medication as may be specially called for, is generally sufficient without applications directly to the uterus.

In those cases that call for internal applications, one pole may be applied to the os, by means of an insulated cup-shaped electrode, or to the interior of the uterus by the intra-uterine electrode, while the other is applied to the abdomen above the pubes, and alternately over either ovary.

Dysmenorrhœa.—In neuralgic dysmenorrhœa, the prognosis is quite uniformly good. Indeed, the results are frequently most brilliant, and follow after years of ineffectual efforts by other means, to relieve the periodical seasons of distress. In my own experience, I have observed successes follow various methods of treatment with both currents. As a rule, however, the galvanic is far more effective than the faradic in affording relief, although in many cases I have found it useful to alternate the two. Internal applications also must frequently be resorted to; yet some of the most striking results come from simple external applications.

Case XIII.—In the case of a young lady, aged 22, sent to me by Dr. George A. Peters, of New York, menstruation had for years been attended with severe pain. No examination was made; neither were any of the applications internal. General faradization alternated with external localized galvanization in the interval between the periods, resulted in an entirely painless menstruation.

From among many unpublished cases, I desire to transcribe one that is still under observation, for the reason that it presents points of interest that are seldom found.

Case XIV.—Mrs. —, aged 28, was sent to me for electrical treatment by Drs. John T. Metcalfe and T. G. Thomas. The patient was large and well nourished, and presented every appearance of one in vigorous health; yet there had been in the past a very considerable derangement of her nervous equilibrium. There was usually only slight pain preceding the onset of menstruation, increasing a little as it made its appearance. In about forty-eight hours, the distress became very great, and continued without abatement, for several days up to the cessation of the catamenia. Careful examination by Dr. Thomas revealed no mechanical constriction, and it was suggested that the probable cause was a tonic spasmodic contraction of the os uteri, resulting from reflex irritability. This condition of affairs had been almost constant for four years, notwithstanding varied methods of treatment, and the propriety of incising the cervix had been seriously considered.

I will briefly describe the method of treatment substantially followed out, and then refer to the results.

I alternated the use of the faradic and galvanic currents, administering four applications a week. External treatment was alone employed, because of the disinclination of the patient to submit to internal applications. The faradic current was used by the method of general faradization—each seance being ended by a purely local application.

In using the galvanic current, the first half of a seance of eight minutes was devoted to galvanization of the whole length of the spine by the labile method, the operation being concluded by a local stabile application. Beginning at each seance, with a current from ten ordinary zinc-carbon elements, the number was gradually increased to twenty-four, and then as gradually decreased. Treatment was begun on *May* 23, 1878. On *June* 3d, the menses appeared, and although by no means painless, far less distress was experienced than usual. The courses ceasing, treatment was continued up to *June* 29. Their second appearance was attended by absolutely no pain worthy of mention.

The patient now left the city for the season, and in due course the menses appeared for the third time since the beginning of treatment, and unattended with any sense of discomfort. Attending their fourth appearance, however, there was very decided pain, and on *Sept.* 11th, on her return from the country, the electricity was resumed. After a few applications of the galvanic current, pains, supposed to be premonitory of menstruation, were felt, and so increased, that Dr. Metcalfe was called in, and found that the patient was suffering from a miscarriage.

Having recovered from this mishap, electricity was again attempted, and has been followed by a gradual improvement to the present time of writing. Since the expulsion of the embryo, there has been more or less discharge of membrane at each period. This has somewhat complicated the case, and although it is still under observation, a complete recovery seems assured.

Connected with this case, two important and interesting questions arise:

1st. Was the electrical treatment in any way efficacious in rendering conception possible? When it is considered that in five years' pregnancy had not occurred, while conception took place soon after the galvanic treatment, which had been so effective in relieving the pain and its probable causation, viz., spasmodic contraction of the os uteri, it is not difficult to believe that its agency was very great.

The second question relates to the possibility of this miscarriage being in any way due to the treatment. In the first place, it is well known to every electro-therapeutist (although the contrary opinion is quite prevalent) that it is exceedingly difficult, and, *as a rule*, impossible, to cause an abortion by any ordinary external application of electricity—external or internal. In this statement, intra-uterine applications are, of course, not included, nor those susceptible cases with a tendency to abort upon the reception of any strong or sudden impression of mind or body. I have treated women in all stages oi pregnancy for various nervous difficulties, and have never yet seen harm result. To produce any mechanical or reflex effects sufficient to detach the fœtal connection, necessitates a degree of current strength not ordinarily required in therapeutics. Again, the severe illness of a near relative had taxed our patient to an extent sufficient in itself to account for a result that would have been gladly avoided.

Menorrhagia.—The causes of menorrhagia are so diverse, that it is manifestly impossible to intelligently prognosticate its behavior under any method of treatment, without some knowledge of its origin. Now it is well recognized, that whenever we have a case of this kind, it either depends on some cause seated in the constitution generally, or on some local sexual disorder. An excessive flow at the menstrual period may be associated with granular degeneration of the kidney. We find in this condition, an altered state of the blood; it becomes attenuated, and readily escapes from the engorged vessels. Under these circumstances, there can, of course, be no indication for the use of electricity.

When, however, an excessive flow occurs (as it does, not infrequently, and especially towards the decline of sexual activity), in consequence of inactivity of the liver, and constipation, associated with a degree of nervous exhaustion, the indications are self-evident, and are often excellently met by the powerful constitutional tonic effects of general faradization. From such local causes of menorrhagia, as misplacements, intra-uterine morbid growths, and certain affections of the ovaries, electrical applications are ordinarily of doubtful efficacy.

The following case is of interest, on account both of the persistency and severity of its symptoms, and its uninterrupted progress toward complete recovery under the treatment adopted. Powerfully illustrative as it is of the efficiency of electrical treatment in certain hæmorrhages, it would not commend itself so favorably, to my own mind, at least, if it were unsupported by more extended clinical observation, and without the rationale of the effects of the method was susceptible of explanation. I have seen, not only uterine, but other forms of hæmorrhage—especially from the rectum—modified and checked by this form of treatment, in quite a number of instances.

Case XV.—Mrs. B., aged 46, consulted me in consequence of severe hæmorrhage to which she was periodically subjected. Five years prior, she observed some slight increase in the menstrual flow. It became increasingly abundant, until, in the course of a year, the loss of blood at each menstrual epoch was frightful. For the first day or two only, was the flow thus alarmingly copious, but its immediate effects were to render her completely colorless and almost pulseless. The flow would now rapidly become less, but for two or three weeks there was a very slight although constant discharge of bright arterial blood. The courses did not appear with normal regularity, an interval of six weeks to two months ordinarily occurring. It is quite evident that if menstruation had occurred every four weeks, the patient could hardly have survived for so long a time her repeated depletions; and, as it was, she was just enabled, by the aid of a good appetite and vigorous digestion, to regain a measure of strength and color before the recurrence of her trouble. I began treatment in the decline of one of these hæmorrhages; and for the relief of the persistent insomnia resulting from her anæmic condition, and the pain in her legs, general faradization was administered on alternate days. It aided very greatly in inducing sleep and relieving pain, and markedly hastened returning strength.

Shortly after these tentative applications were begun, I met at the house of the patient, Dr. W. G. Alling, of New Haven, Conn., under whose care she had been a short time before, and from whom she had received continued and judicious treatment, both constitutional and local, but without decided relief. Dr. Alling's examinations had found the uterus to be three and one-half inches in depth and slightly retroverted. When the probe was carried into the cavity at the first examination, slight hæmorrhage followed its withdrawal, and a small fungoid mass came away. Further examination revealed considerable fungoid degeneration of the mucous membrane. I proposed alternating the general treatment with intra-vaginal and mild intra-uterine applications. This method of procedure was repeated up to the day of menstruation—the patient, in the meanwhile, having regained, with far more than ordinary rapidity, her color and strength. The flow was considerably more profuse than normal, but could not be compared in severity with those that had previously occurred. In ten days, the flow ceased, and treatment was continued until the return of the catamenia, when a still greater improvement was evident. For three months, this treatment was kept up, when the patient left the city for the summer, with the feeling that her recovery was an assured, if not an accomplished fact. Four years have since elapsed, but there has never been a recurrence of these hæmorrhages; and, moreover, the patient has been ever since, and is still, in the enjoyment of robust health.

Paralysis.—In hemiplegia, due to brain lesion, two periods relating to electrical treatment have been designated. 1st, A week or two after the attack; 2d, A month or six weeks from the seizure. In the first period, a mild galvanic current is applied through the head as nearly as possible to the seat of the effusion, and allowed to pass two or three minutes—extreme care being, of course, exercised in increasing and decreasing the current strength without interruption. By thus acting slightly on the cerebral circulation, it is claimed that the absorption of the clot will be hastened. In an experience founded upon more than one hundred cases of hemiplegia, I am pretty well convinced that nature is not materially assisted in her efforts to absorb a brain clot by any direct method of treatment. Considering the extraordinary power of the galvanic current to promote absorption, as shown in numberless cases of electrolysis of tumors, it does, indeed, seem plausible, that here also similar effects might result. The extreme caution, however, that should be observed in galvanizing the brain, because of the danger of too decidedly disturbing the cerebral circulation (the supposed factor influencing the absorptive process), necessitates a current so mild as to be practically useless for this purpose. In the few cases where undoubted and marked results followed galvanization of the brain, I should be inclined to ascribe the paralysis to some cause other than effusion, due perhaps to stasis in the vessels, sufficient to produce decided pressure. I believe, however, that much good may be accomplished in many cases of hemiplegia due to effusion, by general faradization, supplemented (according to the indications afforded by the condition of electro-muscular contractility) by systematic galvanization or faradization of the paralyzed members. These methods of procedure belong to the second period, and may often be kept up with advantage for several months.

Infantile Paralysis.—The use of electricity in infantile paralysis is indispensable, and the results that follow are often most gratifying, and even brilliant. In offering any prognosis, we must be most careful to distinguish between the so-called essential paralysis of childhood, with which organic changes are invariably associated, and a much less serious disorder, mostly peripheral, and due to reflex influences. In our prognosis, we depend very much on the degree of muscular reaction to the current.

If the farado-muscular contractility is entirely abolished, while yet there remains distinct galvano-muscular contractions, we have good grounds for believing that much may be accomplished by persistent treatment.

If the galvano-muscular contractility is also lost, the case is generally hopeless; for with the absence of this reaction, we expect to find muscular atrophy and degeneration.

In the treatment of infantile paralysis, we are guided in our selection of the proper current by the phenomena of muscular contractility. If the muscles respond with considerable readiness to the faradic current, I begin its use immediately, and seldom find it necessary to resort to galvanism. If the faradic current induces but very slight contractions, I alternate its use with mild galvanic currents. If there is no response to faradism, the galvanic current is called for, and should be used until there is some indication of farado-muscular contractility, when the faradic current should be gradually substituted. These very general rules must not be relied upon as *absolute* guides, but they are about as explicit as can be given here, and will be found most valuable aids in practice.

Peripheral Paralysis.—Of the many forms of peripheral paralysis, facial is one of the most common and important, and in passing we will allude to it as an example of this variety. The diagnosis is made easy, not only because in paralysis of the seventh pair of central origin, the eye can be closed, while if the cause is peripheral, the orbicularis palpebrarum muscle is paralyzed, preventing complete closure of the lids; but from the further fact that when the cause is central, the electro-muscular contractility is unimpaired, while if the cause is peripheral, the muscles refuse to respond to the faradic current—although galvano-contractility may be normal, or even increased. The prognosis of facial paralysis is, in general, exceedingly favorable, the differential indications for the use of the currents being much the same as in cases of infantile paralysis.

Anæsthesia.—Anæsthesia, although merely a symptom—as varied in its manifestations as there are nerve ramifications, and grave or trivial, according to its cause—is, in its prognosis (waiving, for the moment, all questions of causation or pathology), usually very favorable. Even the numbness that is so often associated with paralysis of motion, is frequently very much alleviated by the electric brush, although the paralysis itself may not be at all susceptible of improvement, excepting so far as the dissipation of the numbness may afford relief.

Rheumatism.—At one time during the earlier history of faradization, few diseases were supposed to yield more readily to electricity than rheumatism. Much of the reliance that was placed upon it, was due, in part at least, to a strong tendency to speedy recovery in many acute and sub-acute cases of the articular variety of this disease. While an increased experience has very much modified my enthusiasm in regard to the efficacy of electricity in these cases, there can be no doubt that it is often of much service. In the acute and sub-acute forms, it is useful in relieving pain and reducing temperature; while in muscular rheumatism, it is often especially effective; and yet cases are constantly met with of this last variety upon which the treatment makes so little impression as to seem almost valueless.

In order to get from electricity the best results, it will not do to rely on simple local applications. Rheumatism is of that class of constitutional diseases having special local manifestations, and therefore demands constitutional as well as local treatment. If this truth is borne in mind, far better results will reward our efforts, than if reliance is placed on applications simply to the part affected.

Miscellaneous Diseases.—In addition to the above, there are various other diseases and isolated symptoms where electricity is known to be of more or less value. Without attempting in detail to consider them in their electro-therapeutical relations, the following enumeration is given as a very general guide:

Paralysis Agitans.—In the treatment of this disease, the galvanic current is mainly indicated by the methods of central and spinal galvanization. Although a complete cure is rarely and perhaps never effected, excepting in those cases unassociated with serious organic lesion, yet the relief afforded is often very great after a combination of central and peripheral treatment. I have not infrequently seen violent tremors abated, and even completely arrested for several hours.

Progressive Locomotor Ataxy.—The proportion of cures of spinal sclerosis, under any method of treatment, is so very small, that when such an apparent result is recorded, it is quite natural to doubt the correctness of the diagnosis; yet I am well assured that cases have occasionally recovered, the symptoms of which pointed very positively in the direction of this disease. At all events, there is little doubt but what a large proportion of cases are benefited in some one or more of their symptoms. Electrical treatment almost invariably relieves the associated neuralgic pains and spasmodic contractions. The anæsthesia of the feet and legs which increases the incöordination of movement, may generally be very much decreased. The result of this is seen in increased steadiness of locomotion. Galvanization of the spine with strong ascending currents, should be used, supplemented by faradization of the limbs. If the anæsthesia is profound, it may be treated with good effect by means of the metallic brush.

Progressive Muscular Atrophy.—The prognosis of this disease is not altogether hopeless, although few absolute recoveries can be expected. In cases where there are annoying spasmodic contractions, the galvanic current is generally effective in lessening the irritability; while by the additional use of faradization, nutrition not infrequently becomes so much improved, as to show appreciable increase in the size of the affected muscles.

Writer's Cramp.—Rest is here imperative. If in the earlier stages this is taken, and the proper electrical treatment administered, the symptoms in many cases yield readily enough. In the more advanced stages, it is not difficult to palliate the symptoms, but relapses are prone to occur, and a cure is exceedingly problematical. The faradic current should seldom, if ever, be used. As a rule, it does little good, and may do harm. Spinal and peripheral galvanization are the proper methods; but these also must be used with exceeding caution, for it is possible to greatly aggravate every symptom by applications that are too strong and irritating.

In *Lead Palsy*, farado-muscular contractility is lost. The treatment which is generally beneficial should consist in applications to the upper portion of the spine of a labile descending galvanic current. The affected muscles are most successfully treated by mild interrupted galvanic currents, although the faradic current is by no means useless. In *lead colic*, the pains may be subdued by galvanization of the cœliac plexus.

Angina Pectoris.—The treatment of angina pectoris by electricity is of but doubtful efficacy. The very few apparently successful results, serve only to show that exceptions prove the rule.

Dilatation of the Stomach, due not to organic lesion, but rather to atony, or paralysis of the muscular fibres of the stomach, is susceptible of great improvement under the action of electricity. The galvanic current should be first used, by placing the positive pole on the point where the enlargement is most prominent, and the negative between the third and fourth dorsal vertebræ. This should be followed by a local application of the faradic current, sufficient in strength to produce contractions of the muscular walls of the dilated organ.

In *Incontinence of Urine* in children, it is claimed by some that galvanization of the lower part of the spine almost invariably brings about a radical cure. My own experience does not accord with this statement. In conjunction with other tonic remedies, it is undoubtedly an aid, but uniformly successful results can hardly be expected.

In both *Spermatorrhœa and Impotence*, electricity is not only strongly indicated, but is undoubtedly far more efficacious, taking the cases as we find them, than any and all other methods of treatment.

Galvanism is said to be beneficial when applied for the relief of *Opacities of the Vitreous Body*, and of *Occlusion of the Pupillar Aperture*, the result of iritis. It is claimed, also, that in *White Atrophy of the Optic Nerve*, consecutive to neuroretinitis, the disease may be arrested by acting on the encephalic circulation through the cervical ganglia. In these conditions, however, I have had no experience.

Asthenopia.—This symptom, depending on an absolute or relative deficiency of energy in the muscles of accommodation, or of the internal recti, and accompanied by hyperæsthesia of the retina and of the ciliary nerves, may be very uniformly relieved by the faradic current. I will not say that galvanism is never serviceable here, but my experience, at least, seem to teach that the instances where faradism is not immeasurably superior to galvanism are so exceptional as practically to exclude the latter from consideration in the treatment of this condition.

LECTURE VII.

ELECTRO-SURGERY.

ELECTROLYSIS—GALVANO-CAUTERY.

Electro-surgery includes both electrolysis and galvano-cautery. Wide as is the difference between these two methods, they are yet often confounded, and, therefore, their distinctive features will be carefully noted.

1st. ELECTROLYSIS.—Few surgical procedures have excited more sanguine expectations, and few, perhaps, have more signally failed (in certain directions, at least) to fulfill the brilliancy of their promise, than has electrolysis. It has, indeed, been wounded in the home of its friends, for, unlike other departments of electro-therapeutics, it has not been ignorantly tampered with by the laity, but has been in the hands of the profession alone. It was to be expected that, in the first attempts in this direction, there would be much blundering, many ill-directed efforts and incorrect conclusions. It followed, therefore, that the subject, instead of becoming clearer in its relation to surgical diseases, became even more grossly misunderstood.

By some it was believed that it might be made efficacious in invariably dispersing, not only benign, but malignant tumors; and this high but futile expectation has been excited and fostered by unreliable reports of cures. These extravagant statements in regard to the cure of malignant growths have been made even more improbable, from an evident insincerity in endeavoring to throw an air of mystery around the performance of an operation, calling only for the same knowledge and care demanded by every important surgical process. In the electrolytic treatment, also, of ovarian tumors, while there has been much intelligent and conscientious effort, there has been, on the other hand, not a little insincerity and perversion of the truth. In this presentation, I desire to fairly survey the subject, and to point out what I conceive to be its powers and limitations.

Let me first, however, define and describe electrolysis. It is derived from ηλεκτρον, and λυω, to disengage, and signifies that process by which a compound substance is decomposed by electricity. Although decomposition takes place at both poles, its products and manifestations widely vary, according to the composition of the electrolyte or substance acted upon, and the material of the electrode. The simplest electrolyte is water, and under electrolytic action evolves, at the positive pole, oxygen, and at the negative, hydrogen. Subjecting a solution of iodide of potassium to the galvanic current, the iodide, with the oxygen, appear at the anode, and the alkali, with the hydrogen, at the cathode.. In a solution of common salt, chlorine is evolved at the anode, and oxide of sodium at the cathode. When it is remembered that in the electrolysis of every compound substance, the elements involved are definite in quality and quantity, as well as electro-chemical equivalents of each other, it can be readily understood, that electro-surgery offers as great, if not greater, possibilities of exact and uniform results as electro-medicine.

In order to appreciate to what extent uniform results can be expected in electrolytic operations, let us examine the phenomena that follow the concentrated action of the galvanic current on organic compounds. By inserting needles—one connected with either pole—into a tumor, it is observed that its fluid constituents become decomposed. Oxygen and acids appear at the positive, and hydrogen and alkalies (soda, potassa, etc.) at the negative pole. Following these changes, we have absorption, more or less marked, according to the character of the tumor with which we have to deal. This absorption seems to be the result, both of the disintegrating process, the mechanical irritation of the needles, and the effects exerted through the nervous system over nutrition, and often goes on slowly for many weeks subsequent to treatment. In the case of any small tumor—such as a wen, mole, wart or nævus—disintegration and atrophy take place immediately; and during the operation, the growth will be seen to change in color, shrivel and contract, and in a few days will entirely disappear.

The action of electricity on the blood is almost entirely of a chemical character, and it is by carefully noting the uniform results that follow its action here that it becomes possible to predict such positive results in the treatment of erectile tumors. By immediately electrolyzing the blood as it flows from a wounded animal, or better still, by inserting the needles into an artery or vein, it will be found that a clot—small, firm, and closely adherent—has formed at the positive needle, while at the negative, the clot is softer and lighter colored, with an intimate admixture of foam or froth from the bubbles of hydrogen.

Erectile Tumors.—It is the certainty with which the blood becomes coagulated under the above conditions, that enables us to cure so effectually by this method those bloody tumors upon which, through dread of hæmorrhage, the surgeon hesitates to use the knife. The advantages of electrolysis in the treatment of this deformity are patent. In addition to the absence of any danger from hæmorrhage, the operation, if properly performed, will result in little, if any scar; and as these deformities appear mostly on the face and exposed parts of the body, this fact is of no little consequence.

It must not, however, be taken for granted, from the seeming simplicity of the operation, that unmixed good will follow without the exercise of much care and tact. We must do just enough without doing too much. If the current is not sufficiently strong, or the operation not prolonged so as to effectually coagulate the blood throughout the sac, the flow may become re-established and necessitate a second, and even a third, operation. Then again, if the operation is too prolonged and the current too strong, an ulcerative process may be excited—especially in poorly-nourished children—which may cause subsequent trouble. Indeed, in all such cases, I should, in the light of experience, hesitate to operate until the general health had been materially improved by nourishing food and tonic treatment.

My first successful treatment of an erectile tumor by electrolysis, was in the service of Prof. Frank Hamilton at Bellevue Hospital; and in the many that have undergone treatment at my hands since, I can recall but two that were not entirely successful. In the case of a child, but a few years old, the tumor was located on the head. After the operation, the circulation became re-established, and because of the exceptional and unpleasant symptoms that followed the application so near the retina and nerve centres, I declined to repeat it.

The second failure occurred in the person of a babe, a year old, who was in an anæmic and generally low condition. The tumor was over the upper dorsal vertebræ. Under electrolysis, coagulation readily occurred; but during the following night, the child was allowed to lie upon its back, with the hard enlargement of coagulated blood entirely unprotected. Extensive ulceration followed, which was probably a long time in healing. Of the ultimate history of the case, I am not informed.

As a rule, one electrolytic operation is, in these cases, sufficient; but occasionally where the clot seems solid and firm, and to occupy the entire sac, evidence of a re-establishment of the circulation becomes manifest, and necessitates a repetition of the process. Since the experience, however, afforded by the following case, it has occurred to me that in several instances, where a first operation seemed insufficient, and a second was performed, the first alone might have proved effective.

CASE XVI.—A babe, eight months old, with an erectile tumor about one inch in diameter, and situated on the right cheek, was brought to me by Dr. Jerome C. Smith, of New York. In the presence of Drs. Smith and T. L. Perry, I operated according to the following details: Three three-cornered needles, insulated to within one-quarter of an inch of the points, were, at equal distances from each other, thrust into the three thirds of the enlargement. The needles were then connected with the positive pole, while the negative, consisting of a broad sponge electrode, was firmly pressed on the arm in the region of the deltoid muscle. Beginning with five cells, the number was, without interruption, of course, quickly raised to ten, and the current allowed to pass for ten minutes. Increasing then the number of cells to thirteen, five minutes more were consumed in the operation, when the needles were withdrawn, with the escape of but a few drops of blood.

During the passage of the current, the tumor, through the expansion of the gradually-forming clot, perceptibly enlarged, and at the close of the seance was apparently quite solid. A few days subsequently, the tumor presented a much softer appearance; the circulation seemed, in one part, to be re-established, and the indications were that a second effort would be necessary. The parents, however, expressed dissatisfaction with the method, and absolutely refused to have it repeated. Fortunately for the child, the subsequent result was entirely satisfactory. The contents of the sac hardened again, absorption slowly followed, and the cure was effected by the one operation.

For a long time, I was in doubt as to the best method of procedure in these cases. Whether needles connected with both poles should be introduced, or whether, as related above, only the anode should be used for the purpose of coagulation. Having tested both methods pretty thoroughly, I am satisfied that my best results have been obtained with the needles connected with the positive pole, and the negative applied externally. Although we have in this way a greatly increased degree of resistance, this can be compensated for by augmenting the number of cells, while the advantage to be derived is that the clot becomes firmer and more consistent throughout. The hydrogen developed at the negative pole unnecessarily puffs up the surface, interferes with the firmness of the coagulation, and at the same time there is a greater tendency to discoloration and destruction of the skin at the points of entrance, even though the needles be thoroughly insulated.

Whether needles connected with one or with both poles are used, the greatest care should be taken to avoid any contact of the points after their introduction. In the latter case (where both poles are introduced), complete approximation of the needles would prevent any electrolytic effect whatever upon the surrounding blood; in the former (where needles connected with one pole only are used), contact would not, of course, interrupt electrolytic action, but its efficiency would undoubtedly be interfered with. When we consider the small size of the majority of these tumors, and the number of needles that are to be thrust in, the necessity of caution can be readily appreciated.

Cystic Tumors.—After erectile, small cystic tumors are, perhaps, most successfully treated by electrolysis.

CASE XVII.—In the case of a lad, aged 18 years, who had a cyst as large as an English walnut just above the nose, between the eyebrows, the fluid had been evacuated seven times, but had on each occasion returned. I saw the case with the late Prof. A. B. Crosby, and introduced a partially insulated needle, sharply curved at its point. Connecting this with the negative pole (which, for the treatment of cysts, is to be preferred to the positive), I slowly swept its convex surface along the secreting surface of the sac, at the same time pricking it gently with the point of the needle wherever possible. On withdrawing the needle, after a seance of ten minutes, the enlargement flattened and soon permanently disappeared.

In certain of these cases, instead of the above result, the cyst, owing to its fluid contents being susceptible of coagulation, has been observed to harden until it becomes quite firm. In one such case that fell under my own observation, the ultimate cure was effected as in the case of erectile tumors, through the process of absorption.

Goitres.—Under the influence of electrolysis, goitres act somewhat capriciously, but enough has been accomplished to prove it to be a valuable method of treatment. It is not too much to say that goitres almost invariably decrease more or less in size, and not infrequently disappear altogether. As in cysts, the negative pole is to be used, and the needles should be thoroughly insulated and thrust in to a considerable depth. Before doing this, however, it is as well to try external applications, for, under this treatment also, we generally get a reduction in size, and occasionally absolute dispersion. I have seen several cures wrought by this simple method. One case, sent to me by Dr. J. Marion Sims, in which the growth was of considerable size and standing, has been already reported. A second one is as follows:

CASE XVIII.—Miss C., aged 21, was referred to me in May, 1876, by Dr. M. T. Pultz, of Duchess county, N. Y. The enlargement first made its appearance several years previously, and had gradually enlarged until it was a very appreciable deformity. Under very mild external applications of galvanism, continued for one month, the tumor disappeared, and has never returned.

In those cases where external applications are followed by a certain reduction in size—be it great or little—and then ceases to be effective, the introduction of needles seldom fails to still further advance the process of resolution.

CASE XIX.—Mrs. H., aged 42, came from Newark, N. J., March, 1877, for an opinion, both as to the probability of benefit from an electrolytic operation upon a large goitre, and for her general condition. The tumor had been coming for many years, and at intervals had been treated by various methods—among others, by injections into the substance of the growth, which resulted in some diminution in size, but at the same time set up an ulcerative process which was a long time in healing. Her general health was very poor. She was greatly emaciated, suffered almost constantly from nausea, and was unable to retain sufficient food for proper nourishment. The pulse was from 85 to 90, and through mental or physical disturbance would rise 10 to 20 beats. It seemed probable that there was disease, or, at least, disturbance of the sympathetic, but as there was no protrusion of the eyes, it could not be classed under the head of exophthalmic goitre. The goitre was the largest that I had ever treated, approximating in size an ordinary drinking bowl.

The patient was first submitted to external galvanization (daily) of the growth and of the sympathetic. In two weeks, there was reduction, by actual measurement, of 2½ inches. At the end of a month, no further reduction was observable, but every other symptom had been very decidedly ameliorated. The patient had increased immensely in strength and considerably in weight. The pulse ranged from 70 to 75, and was not at all susceptible to sudden fluctuations. The nausea had disappeared, and the appetite and digestion materially improved.

The needles were now resorted to. Introducing three—connected with the negative pole—at equal distances at the base of the tumor, and applying an electrode, covered with chamois skin, directly over the central surface of the goitre, the circuit was closed, and the current from forty Siemen and

Halske's cells was allowed to pass for eight minutes. At the end of a week, after a single repetition of this process, the original measurement decreased five inches. During the next two weeks, the electrolysis was twice repeated—the last seance being attempted with the ordinary zinc-carbon element, of which twenty were used. The tumor continued to grow smaller until the middle of May, when the enlargement was barely perceptible.

In these cases, the pain resulting from the introduction of the needles, and the chemical action of the current, is but slight; but in deference to the wishes of the last patient, she was given at each seance a few whiffs of chloroform, stopping short of unconsciousness. Although aware of every step in the process, she experienced no pain, and at the last seance bore the operation without an anæsthetic, and subsequently remarked that, had she fully appreciated how slight was the pain occasioned, she would willingly have submitted in the same way to the previous operations.

When we come to consider the larger and more serious forms of morbid growths in their relation to electro-surgery, it must be confessed that the outlook is not greatly encouraging. In the treatment of fibroids and malignant tumors, my experience has been sufficiently extended to enable me to speak with some degree of positiveness in regard to the probable degree of benefit to be derived from electrolysis. In the electrolytic treatment of ovarian tumors, I have, indeed, had but a slight personal experience; but statistics would seem to warrant the conclusion that it is not a method of procedure that is likely to supplant ovariotomy.

Fibroids.—Fibroid tumors are dense and comparatively dry, and do not rapidly shrink and atrophy under electrolysis. Yet, as in the case of goitres, it must be acknowledged that applications to the body of the tumor, may be followed, not only by shrinkage, but by a very great alleviation of the distressing symptoms that accompany this disease, especially when seated in the uterus. The tendency to disintegration and absorption is, of course, much increased, and the danger from peritonitis is but slight; but in regard to the alleviation of pain, less is often accomplished by the needles than by external treatment. In two cases suffering from intra-mural fibroids—one directed to me by Dr. T. G. Thomas, and the other by Dr. James R. Wood—the effects of treatment without resorting to the needle have been of a very positive character. In both instances, the patients were almost completely relieved of all pain, and regained, in a marked degree, their failing strength, and in one case, which is still under observation, there has been a very appreciable decrease in the size of the tumor.

Cancer.—In regard to the electrolytic treatment of malignant tumors, in which I have had no little experience, it can be safely said that by the ordinary methods we can expect but little from it. On the theory of the local origin of cancer, which has been so ably advocated by some, and especially by De Morgan,* there is one method which I believe to be rational, and worthy of investigation. I refer to that process by which, after the extirpation of the growth by the ordinary method (the knife), all the underlying tissue is, by the chemical action of the current, completely and thoroughly destroyed.

My method is simply this: Immediately after the removal of the growth, I place a small harrow connected with the negative, and several platinum needles connected with the positive pole, on the open wound. This appliance called a "harrow" consists of some twenty points projecting from a metal plate, an inch and a-half long by an inch in width. These points penetrate somewhat into the exposed tissue; hydrogen develops in abundance, the tissues change in color and consistency, and rapid and complete destruction follows to a considerable depth. It is necessary to observe some caution in the regulation of the strength of the current and the position of the poles; for if the strength is increased above a certain point, or the position of the poles is such as to affect too directly the pneumogastric, the heart's action becomes alarmingly decreased, both in frequency and force.

I conceive this method to be superior to the ordinary electrolytic process—1st, From the fact that, although two distinct operations are performed, less time is consumed in the operation, and, it is possible, more effectually and to a greater depth to destroy the underlying tissue. 2d, Because the application of the current seems to be stimulating in its effects. When applied so as to affect too directly the heart, it is true that its action becomes weakened; but the moment the tension of the current is lessened, or the electrodes removed to another part, the pulse becomes fuller and stronger. 3d, The healing process is rapid and healthy in all its progress.

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* *The Origin of Cancer*, considered with reference to the treatment of the disease, by Campbell De Morgan, F. R. S. J. & A. Churchill, Publishers, London, 1872.

Ovarian Tumors.—The electrolytic treatment of ovarian tumors has, of late, excited much attention, and I can do no better than to give briefly the conclusions arrived at by Dr. Paul F. Mundé, in a very creditable *resumé*[*] of what has been attempted and accomplished in this department of electro-surgery.

He finds—1st, "That a number of ovarian tumors, reported on reliable authority, have been completely cured or permanently improved by electrolysis; out of fifty-one cases, twenty-eight or about fifty-five per cent.

2d, "In a number of these cases, electrolysis was followed by dangerous (thirteen, or 25.4 per cent.) and even fatal results (nine out of these thirteen, or 17.6 per cent. of the whole fifty-one).

3d, "Further, six cases out of fifty-one received neither benefit nor injury from the treatment, and four were only temporarily improved; total ten, or 19.6 per cent. We thus have a total of twenty-three cases, or forty-five per cent., in which the electrolytic treatment failed to accomplish the object for which it was administered.

* * * *

6th, "Notwithstanding these undoubted cures, the percentage of successes of oöphoro-electrolysis (55 per cent.) compares unfavorably with that of ovariotomy (70 to 80 per cent.; Spencer Wells 78 per cent., in 1876 as high as 91 per cent.). And so also do the deaths by electrolysis (17.6 per cent.) nearly equal those following ovariotomy in recent years (20 to 30 per cent. to 22 per cent.), and far exceeding those occurring in the last series of fifty-five cases of Spencer Wells (five, or 9 per cent)."

Among the various other surgical diseases for which electrolysis has been recommended and used, I mention only the following:

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[*] "The Value of Electrolysis in the Treatment of Ovarian Tumors," by Paul F. Mundé, M. D., New York, *Gynæcological Transactions*, 1878.

Aneurisms.—With this disease I have had but little experience, and the published reports are mostly vague and unsatisfactory. The statistics available are of but little value, and the general average opinion, so far as I have been able to ascertain, is, that while galvano-puncture, skilfully performed, may now and then prove of some service, and has, in rare instances, been followed by a radical cure, it, as a rule, fails to give decided relief.

Varicose Veins have been treated successfully by electro-puncture—in some cases, the positive pole alone being introduced, and in others, needles connected with both poles being used.

In the treatment of *urethral stricture*, there are rational grounds for the use of electrolysis, and considerable has been accomplished in this direction; but that it is equally efficient with other and older methods may be doubted, and there can be no question that, in inexperienced hands especially, it may work decided injury.

The cure of *old ulcers* can unquestionably be much hastened by electricity in either form, but the electrolytic effects of the galvanic current are much to be preferred. I have seen marked changes for the better follow a single application, but this is rare. The so-called body batteries, consisting of discs of zinc and silver connected by a wire, are frequently efficient.

Abscesses.—The faradic current has, as I have often demonstrated, a remarkable effect in hastening the development of abscesses. So far as this relates to acute abscesses, it is, perhaps, of minor importance, since the ordinary method of poulticing is sufficient; and yet, even here, when the abscess is seated in some inaccessible part, as in cases of tonsilitis, electrical applications prove of great service. It is in strumous, or so-called cold abscesses, however, that this method is chiefly to be commended, and for it, I know of no substitute of equal efficiency. Its value is very positively demonstrated by the following case:*

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*Published in the *New York Medical Record*, Sept. 21, 1878.

CASE XX.—Mr. R. C., aged about 30, a patient of Dr. S. T. Hubbard, was sent to me in November, 1876. I found a tumor about the size of an orange, situated on the right side of the neck, partially under the body of the sterno-cleido mastoideus muscle. In 1869, he had received a severe strain while rowing in a college regatta, and soon after, this unsightly enlargement made its appearance.

He had been under the care of Dr. Sieveking, of London, and afterwards of Dr. Piersons, of Orange, N. J., who had used the galvanic current (external applications). Supposing (with others whom he had consulted) that it was either a solid enlargement or an ordinary cyst, I proposed electrolysis; but in view of the fact that the patient thought it had decreased a little in size under galvanization as used by Dr. Piersons, and desired a continuance of the trial, the introduction of the needles was postponed. I alternated galvanic with faradic applications, and in about two weeks, instead of observing a decrease in size, or, as I had expected, no change whatever, the growth appeared perceptibly larger. It was evident to my mind that pus was forming, and on the following day the late Professor A. B. Crosby, who saw the patient with me, introduced a small trocar, which, on withdrawal, showed a slight but sufficient trace of pus. I continued the applications several weeks longer, the enlargement gradually increasing and growing more sensitive, until it was pronounced quite ready for an operation. On etherizing the patient, Prof. Crosby made a free incision, perhaps four inches in length, down to the cyst wall, or, as it is technically called, the pyogenic membrane. This wall is said to increase in density with age, varying from an eighth of a line to an eighth of an inch in thickness. In this case, the membrane was fully an eighth of an inch thick, exceedingly vascular, and of such a consistence, that the knife could with difficulty penetrate it. The discharge of pus was very great, probably half a tumblerful or more. The usual after-surgical treatment was employed, and after the healing of the wound, no trace of an enlargement was visible, and to this date the patient has had no further trouble.

The rationale of the effect of the treatment above given, is, it seems to me, sufficiently clear. While electricity, in passing through living tissue, exerts influences that widely vary, all of which may enter more or less as factors in increasing the activity of the suppurative process, it is probable that the mechanical effects of the faradic current is mainly efficacious. It is a current of alternation, of to and fro motion, of constant closing and breaking. When it passes through the body, even when it produces no appreciable muscular contractions, it acts very much in the same way as gentle pounding, or tapping, or rubbing on the tissues; and this gives passive exercise to all the deeper-lying as well as the superficial tissues. We may believe that the molecules of the tissues are agitated by the passage of the current, as the particles of a bar of iron are moved by the influence of magnetization, or as bodies are expanded by heat.

Now, while it is by virtue, in part, of these phenomena, that we obtain tonic and restorative effects in ordinarily vitalized tissue, we can readily understand how, when acting on parts where the destructive process has begun, they may act as excitants, and very materially accelerate the breaking down of tissue, and the consequent formation of pus.

REMOVAL OF HAIRS BY ELECTROLYSIS.

At the last meeting of the New York State Medical Society, Dr. Geo. H. Fox presented a paper "*On the Permanent Removal of Hairs by Electrolysis.*" A fine platinum, or irido-platinum wire is attached to the extremity of the negative cord. This is to be inserted into the hair follicle to a depth sufficient to reach the hair papilla, and the circuit is completed by the application of a small sponge-tipped positive electrode to the surface of the skin in the neighborhood. From five to eight cells of an ordinary zinc-carbon battery may be employed, and the current allowed to act until a destruction of tissue is indicated by a slight frothing around the needle, at the mouth of the follicle. This will necessarily occasion a certain amount of pain, but no more than most ladies will joyfully undergo in the hope of getting rid of their superfluous hair. Where the follicles are large, as on the cheek, the hairs should be removed before the insertion of the needle. Where the follicles are small, it is better to insert the needle beside the hair, and, if the papilla is reached by the point of the needle, the success of the electrolytic action will be shown by the ease with which the hair can be extracted. The operation requires a good light, a sharp eye, and extreme care on the part of the operator; and with these, according to Dr. Fox, gratifying results may be expected.

Needles with Various Forms of Holders for Electrolysis.—(*Kidder.*)

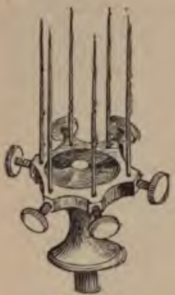

Fig. 12.

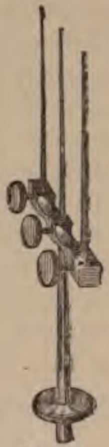

Fig. 13.

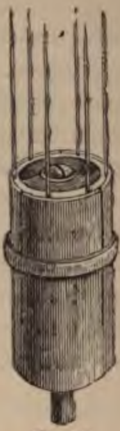

Fig. 14.

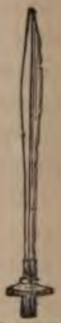

Fig. 15

Although the holders above illustrated are occasionally very convenient, yet, as a rule, I prefer to have the needles fastened separately to the electrode by flexible wires. The only objection to this method is, that interruptions in the current are apt to occur during the operation, unless the wires are sufficiently flexible and very carefully adjusted. It will be observed that figures 12 and 14 have each six needles. Now it is impossible to thrust all these at once into any tissue of ordinary consistency; hence in any case where the needles can be successfully used, grouped in the manner above indicated, I have been accustomed to introduce each one separately, and when they are all in position, to fasten them to the holder.

Figure 15 is a double edged spear-shaped knife for electrolysis. I have often used this very successfully in undermining and removing bodily, malignant growths, especially those of an unusually vascular character. At the same time that the tumor is removed and the hæmorrhage checked, the electrolytic action causes a very decided destruction of the underlying tissues.

II. Galvano-Cautery.—In the light of Ohm's law, as well as in the light of experience, the erroneous notion that large cells have any marked advantage over small cells for electrolytic operations, becomes sufficiently evident. It has been seen that for the effective electro-chemical decomposition of any organic compound, we require quite a number of cells of medium size. If they are very large, we have a bulky, unwieldy battery, which, by no means yields any adequate compensating advantage of increased chemical power. If, on the other hand, the cells are very small, although they will, for a brief period work to entire satisfaction, their reserve power is so small that they yield little steadiness of current; this again fluctuates from moment to moment, and owing to the polarization of the elements and the deposition of the salts in the solution, rapidly weakens. For the purposes of *galvano-cautery*, however, large cells, strongly charged, and from two to six in number, are required.

Now, as it has been found by experiment, that the heat developed by the current in any wire is proportioned to the resistance of the wire, and as platinum offers a greater resistance to the passage of the electric current than any other metal (except mercury and lead), it alone is used in galvano-cautery. Though platinum wire resists the current very powerfully, as compared with silver or copper wire, it offers a very small resistance as compared with water, or the human body, or *very long* wire of any kind. Hence, in the galvano-cautery instruments, the *external* resistance is small, being not very much greater than the internal resistance of the batteries—perhaps not so great. Before a large external resistance—the human body, or very long coils of wire—the surface of elements is used to the best advantage when cut up into small cells. Before a small resistance, the surface of the elements is used to best advantage when cut up into a few large cells; or if the external resistance be very slight indeed, a single large cell will answer; for it has been shown that, in a short circuit, one cell gives as much quantity of electricity as one hundred, or, indeed, any number.

By galvano-cautery, then, we understand cauterization by a resisting wire heated by the galvanic current—the electricity itself not being applied to the body as in the various forms of electrolysis, but only the wire heated by the passage of the current. However obtained, heat is heat; and consequently the heat obtained by galvanic action has probably no advantage, as such, over that obtained by thrusting cauterizing irons into glowing coals. The great advantage of the galvano-cautery over the actual cautery lies not only in the fact of the complete and perfect control that the operator has over the first, even in prolonged operations, but that it enables one to operate on portions of the body ordinarily inaccessible, and by methods impossible with the actual cautery. In those conditions for which it is adapted, it possesses various advantages over the knife, one of the most important of which is its well-known power to prevent all or nearly all hæmorrhage. Hence, certain operations which would, by the knife, be attempted with dread and attended with danger, become, by the use of the galvano-cautery, perfectly simple and safe. Like electrolysis, it is often followed by a more satisfactory healing than by the knife or ligature, and by a decreased tendency to pyæmia.

The purposes for which electro-cautery have been recommended and employed are numerous, and the indications for its use will readily suggest themselves to every surgeon. Its best results are, perhaps, obtained in the removal of tumors situated in parts not accessible to the ordinary methods of extirpation, and for the removal of growths that are exceedingly vascular, and especially those of a malignant character. For the various purposes of cauterization, this is, of course, a ready and effective method. It can be used also with advantage in certain cases of fistulæ; but the treatment of neuralgia by cauterizing and killing the nerve, and of treating prolapsus uteri by cauterizing with the burners the vaginal wall, thus causing inflammation, suppuration and ciccatricial contraction, are heroic measures in which I have had and desire no experience. To properly care for and utilize the galvano-cautery, demands not a little experience, together with that attention to detail, which is so especially requisite in every department of electro-therapeutics.

The ordinary galvanic apparatus used in electro-medicine and for electrolysis can be used many times with the same fluid; and when its strength begins to weaken, a little addition of new fluid will increase its efficiency. In the galvano-cautery battery, however, not only must the solution be much stronger, but for each operation it must be renewed. Previous to an operation, the apparatus should be thoroughly tested, and the platinum wire and knives, and especially the handles, carefully examined, in order to detect any incomplete connection or faulty working of the screws or wheels. Before the circuit is closed for the generation of heat, the wire loop should be accurately adjusted; and when encircling mucous membrane, should not be strongly contracted until the submucous tissue is reached. When passing through superficial or cellular tissue, the wire should not be brought to a white heat. It should be remembered that the amount of heat generated may be too great as well as too little, and, therefore, the adaptation of current strength should be according to the thickness and length of the wire loop, or size of the cautery knife used, and the vascularity or dryness of the tissue acted upon. If the wire loop be very thin, and the quantity of electricity large, there is great danger that the wire may break before the close of the operation, and cause serious annoyance. If, on the other hand, the quantity of electricity be insufficient, the platinum, whether wire or knife, will become incompletely heated, fail to cut through the tissues thoroughly, and thus increase the danger of hæmorrhage.

Again, when exceedingly vascular parts are to be cut into, as, for example, in amputation of the cervix uteri, it is of the first importance not to use too small a wire. Brought to a white heat, there is not only a possibility that the wire may become fused, but the rapid severance of the tissues is almost sure to be followed by considerable hæmorrhage. By the use, however, of the larger sized platinum loop, amputation of the cervix and other vascular parts is often accomplished without the loss of a drop of blood. In these operations it is safe to use the largest wire that the battery at hand will successfully heat. Towards the close of the operation, as the loop becomes gradually reduced in size, the elements should, by an assistant, be gradually lifted from the solution, thus reducing the quantity of electricity generated.

At every step of an operation, an assistant is needed, whose exclusive duty it should be to see to the working of the apparatus; to raise or lower the cells and to attend to the peculiar manipulation required (whatever it may be), by the battery in use, by which the polarization of the elements are prevented and the current strength increased. The management of the immediate instrument for operation will require the sole attention of the operator. Where malignant growths are to be removed, the wire loop should encircle the healthy tissue as well, so as thoroughly to extirpate the diseased portions. In cases where the situation of the growth is such as to render this impossible, the cautery knife can, in the latter stages of the operation, be often substituted with great advantage for the wire. In all cases, traction of the wire should be very gradual, little force being used for fear of breaking it; but at the same time it should be constantly borne in mind that if the heated wire is not kept taut and closely pressed into the gradually yielding substance of the growth, there is danger equally great that the platinum loop, relieved of the cooling influence of the blood and moist tissues, may yield through fusion, instead of force.

Apparatus for Galvano-Cautery.—The advance in the construction of galvano-cautery batteries during the past decade has been very great. Apparatus combining portability with power, are readily obtained, and those manufactured by Kidder and the Galvano-Faradic Manufacturing Company and the instruments of Dawson & Byrne are all of great efficiency. The most successful attempt to combine a suitable degree of strength, with compactness and lightness, has, perhaps, been made by Kidder in the battery represented by Fig. 16. It is composed of but two hard rubber cells, with elements of zinc and carbon—each cell measuring 3½ inches in length, 2½ inches in width,

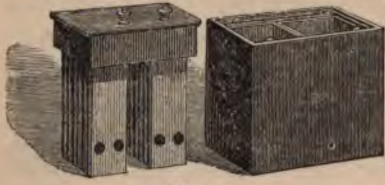
FIG. 16.

and will retain a number 19 platinum wire at a white heat for more than a quarter of an hour. The elements are made to move on small wheels horizontally, in their relation to the fluid in the cells. This is a great improvement on the old method of blowing with an air bulb for the purpose of producing agitation of the fluid, and consequent increase of current strength, and seems to me to more thoroughly displace the battery fluid than any other method. For very prolonged operations this little battery is hardly sufficient, and should be replaced by the larger form, consisting of four cells.

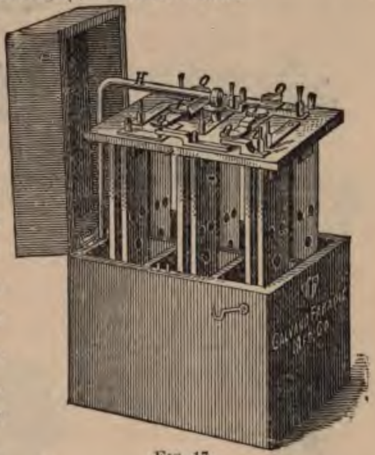

FIG. 17.

Figure 17 represents the Piffard galvano-cautery battery, and is not only reasonably compact, but exceedingly efficient. The box contains six cells of vulcanite and a platform of hard rubber, to which are fastened the zinc and platinum plates. On the top of the platform are seven conducting posts, six connecting screws and a handle (used in connection with the long arm) for holding the elements when not in use and by which they are lowered into, or taken from the cells. For the purpose of agitating the fluid and increasing the cautery power, there are pivots on each side of the platform, by means of which the elements are readily moved with a rocking motion. The box enclosing the cells is 9 inches long, $6\frac{1}{2}$ inches wide and ten inches high.

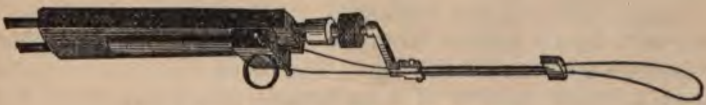

FIG. 18. Cautery handle with loop, ready for operating.

Figure 19 illustrates the manner in which the holder is best grasped for the purpose of drawing the loop in amputations. With the thumb in the slide, as indicated, the sweep of the hand is greater than by any other method.

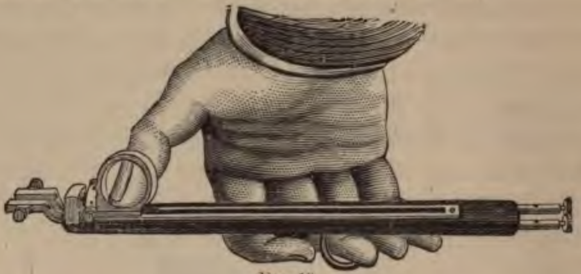

FIG. 19.

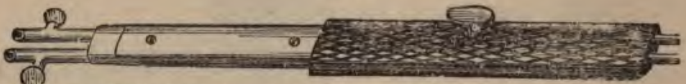

FIG. 20. Handle for platinum knife or burner, with spring for closing and interrupting the circuit.

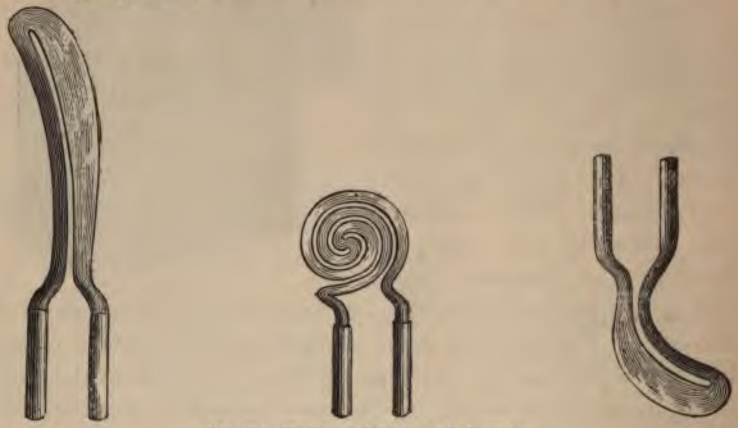

FIG. 21. Platinum Knives and Burner.

The following operation by the galvano-cautery is a good illustration of its value and efficiency.

CASE XXI.—I was requested by Prof. James R. Wood to see with him a patient from whom he had some time before removed a cancer of the lip. The man was now suffering from a larger growth of a malignant character, situated on the right side of the neck, and adherent apparently to the hyoid bone. The tumor was so exceedingly vascular that it was thought not expedient, by Dr. Wood, to use the knife, and he therefore determined to try the galvano-cautery. The patient having been etherized by Dr. J. W. Hunt, of

Jersey City, who had the immediate charge of the case, Dr. Wood proceeded to dissect back the skin; but the substance of the tumor was found to be so thoroughly broken down, that it was resolved to extirpate thoroughly, without regard to its covering. The circumference of the tumor was so great, that instead of attempting to encircle the whole at once, Dr. Wood pierced it at its base and centre by a grooved director, and along this I thrust the free end of my platinum wire, and as it came out at the opposite side, it was fastened in the other half of the operating handle, thus forming a loop around one-half the tumor at its base. The circuit was now closed, the loop gradually contracted, and the amputation of the portion enclosed speedily accomplished. The other half of the enlargement was, in the same way, readily cut away. Substituting now the cautery knife for the wire, as much of the underlying tissue was removed as could be with safety attempted, owing to the position of the disease. During the operation, only an insignificant amount of blood was lost, and but one small artery called for ligation. No untoward symptoms followed, and the patient made a good recovery.

APPENDIX.

A Case of Dysmenorrhœa, due to Spasm of the Os Uteri.

The following case, which fell under my observation too late for insertion in its proper place, confirms in a very interesting manner, the suggestion offered in Case No. XIV, and I offer it as a brief supplementary contribution to the series that I have just completed.

In the case alluded to, the dysmenorrhœa was attributed to spasmodic contractions of the os uteri, and the propriety of incising the cervix had been seriously considered.

Case XXII.—Mrs. D., aged 33, the mother of three children, consulted me December 23, 1878, for excessive dysmenorrhœa, from which she had suffered for over five years. At the same time, the flow was very much greater than normal, resulting in constant anæmia, and an exhausted condition, from which she barely recovered before a recurrence of the menses. The patient had, for years, been the victim of uterine displacement, which she had failed to have permanently rectified, and to it she attributed her sufferings. Upon examination, I found a simple anteflexion, associated with a very great degree of tenderness of the vaginal walls, and especially of the os itself. So tender were these parts during the week preceding menstruation, that very slight internal pressure caused intolerable pain. The acute distress from which she periodically suffered, usually began about 36 hours before the appearance of the menses, reaching its height as the flow became manifest. From this time, the pain gradually decreased in severity, and during the last two days of sickness was very slight.

Having in mind the case to which I have alluded, where the dysmenorrhœa was supposed to be due to spasmodic contraction of the cervix, I was led to make a digital examination about twenty-four hours before menstruation, and while the patient was suffering pain of the most distressing character. On touching the os tincæ with my index finger, and sweeping it around on every side, the constriction and relaxation of muscular fibres were distinctly appreciable, being evidenced by the alternating hard and soft feel of the uterine neck. Hoping that some immediate relief might be afforded, I attempted the following treatment:

Placing the patient on her back, I introduced several small sponges, somewhat after the manner suggested to me in another case by Dr. T. G. Thomas. The sponges, as fine and soft as possible, were carefully packed around the cervix, pressing up against the body of the uterus, and completely covering the os. Against these was gently, but firmly, pressed a flat metallic electrode, covered with wet chamois skin, and this again was connected with the anode. Connected with the cathode, was an ordinary sponge electrode, which was firmly held on the abdomen above the pubes. Intercalating a rheostat, and beginning with the least possible current strength, it was gradually increased, until a slight pricking sensation was felt under the external electrode. The action of the anode, on the contrary, was accompanied by no pain, but its effects were evident; for, from the moment the circuit was made, the rest from pain, which had before been excessive and constant, was complete. After an application of ten minutes, the current strength was gradually decreased to its minimum, and discontinued. The remission of pain continued for ten hours, when some distress was again experienced, which increased, and on the appearance of the flow became quite severe. At the cessation of the menses, general faradization was alternated with external applications of the galvanic current to the spinal cord and abdomen. As the next period approached, pain began, as usual, about 36 hours before hand, and although much less severe, there was not, as before, anything like a complete remission. The amount of blood lost was, however, decidedly less.

During the second month, the external application of both currents was continued, and on each of the three days preceding menstruation, internal applications were given, according to the method first attempted. The flow was established and continued throughout without the slightest suspicion of pain.

During the past month, the patient has not been subjected to any treatment, and at this date (March 24th) she has just completed her fourth menstruation since I first saw her. Not only has it been entirely painless, but the flow was also normal.

I may add, that in no form of disease have I, for some years, been more interested, as it stands related to electro-therapeutics, than in dysmenorrhœa. It need not be told what a scourge it is, and how common, and above all, with what persistency it often resists ordinary methods of treatment. There are, beyond question, thousands of women who have suffered for years in this way, and are yet perfectly curable. If this painful symptom be due solely to mechanical causes, there can be little, if any, indication for the use of electricity in any form; but where it results from nervous disturbances, which do or do not cause spasmodic muscular contractions, this agent, properly employed, has proven itself all powerful to relieve.

But while mechanical dysmenorrhœa does not, as a rule, call for electrical treatment, it must not be supposed that, in all cases where versions or flexions are *associated* with painful menstruation, they stand related as cause and effect, and it is for the purpose of emphasizing this truth, as well as to give additional weight to the testimony concerning the relation of spasmodic action of the cervix to dysmenorrhœa, and its relief by electrization, that I have given the above.

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